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STATISTICS OF BARATARIA.

II.

By Grant Allen.

IF we look away from our imaginary instance of Barataria, and apply the curious statistical facts we there arrived at to actual cases of mixed population in the real world, we shall see how very misleading is that kind of ethnology which bases itself entirely on historical or quasi-historical data. Let us take, for example, the case of England.

People often talk as though the ethnical elements in the population of England must be the same at the present day as they were shortly after the Norman Conquest. It is common to hear thinkers of the purely historical school take it for granted that the proportions which then obtained must still obtain throughout the nation. I believe this to be very far from the real truth. It seems infinitely more probable, in the light of the statistics given by Mr. Galton, that every race is always in a state of perpetual flux; that large numbers of families are always dying out; and that other families are always increasing and spreading at an extremely rapid rate. If we could take a glance at the England of the twelfth century, and enumerate all the families it contained, it appears likely that we should find ever so many of those families had died out utterly meanwhile, whereas the remainder had increased so greatly as to form the bulk of the existing English people in our own day.

Now, I don't want to press this argument here so as to favour any one particular ethnological theory as to the composition of the modern British nation. I don't believe the time has yet arrived when it would be possible to do this with even the slightest approach to rough accuracy. In order to apply the idea here set forth to concrete ethnology, it would be necessary to make prolonged and systematic research among church registers and other genealogical documents in all parts of the kingdom. But what I want to point out at present is the fact that this particular factor—the relative fertility of special families and special races—is really all-important to the proper study of ethnography. Let us suppose, for example, that at any given period the population of Britain consisted one-half of Teutonic Saxons and one-half of indigenous Celts; then, if the Saxon women marry on the average at seventeen, and have on the average nine children each, they must have been rapidly increasing ever since; while if, conversely, the Celtic women marry on the average at thirty-two, and have on the average some four children apiece, they must have been steadily decreasing in number ever since. But if, on the contrary (as is more truly the case), the Saxons marry later and the Celts earlier, then the Celts must have been gaining continuously upon the Saxons, and must, in the long run, be gradually supplanting them.

As a matter of fact, however, in every country where we get varieties of race inhabiting contiguous districts, intermixture continuously goes on; and this intermixture still further increases the difficulty of arriving, by historical research, at any definite result. Still, there is one way in which some approximation may hereafter be obtained, as regards the total of the several proportions, and that is by observation and enumeration of surnames, so far as they can be shown to indicate race. For though a daughter who marries loses her father's surname, and so in mixed marriages merges the marks of her own ancestry in her husband's, yet, since as many mixed marriages are likely in most cases to take place one way as the other (for example, as many Celtic men will marry Teutonic women as Teutonic men will marry Celtic women), the women on both sides may be considered to cancel out, and we shall get approximately correct results by reckoning the father's side alone. In short, though a great many Smiths and Browns may be very largely Celtic, yet an equal number of Macphersons, Evanses, and O'Briens are no doubt very largely Teutonic.

There are, however, a few cases where intermarriage has long taken place on one side only. Take, for example, the Turks in Europe. It is usual to talk of the Turks as Tartars. So far as language and manners are concerned, this may be true enough; but, ethnologically, it is quite untenable. For years Turks have habitually had in their harems Circassian, Greek, and Slavonic women. Any so-called Turk whose mother was Circassian is only half Tartar; if his father's mother was also Circassian, then he is only one-fourth Tartar; if his paternal grandfather's mother was also Circassian, then one-eighth; and so on in a rapidly-vanishing proportion of Tartar blood. I say this without political prejudice for or against Turks; for, so far as I have read, Tartar, Turk, and Circassian are pretty much six of one and half-a-dozen each of the two others.

It must be remembered, too, that in all times and at all places town population tends relatively to die out rapidly, while rural population tends to roll in upon the towns, and swamp their original ethnical peculiarities. For example, most of the great towns of Britain are situated in what was (during earlier ages at least) the most Teutonic part of the kingdom. But they are nevertheless saturated through and through with Celtic immigration. Glasgow is full of Highland Scots and Irishmen; Liverpool and Bristol of Irish and Welsh; London of all three put together, besides a strong contingent of Cornishmen and half-Celtic Devonians. The rural districts of the Highlands, of Wales, of the west country, of Ireland, are the great breeding places for the modern British races. The people there marry early and rear large families; part of their surplus population finds an outlet in emigration, and helps to people America, Australia, and the colonies generally; the remainder rolls back upon the towns, where it intermarries with the natives, and soon merges in the mass of

inhabitants, while still retaining all its original ethnical peculiarities.

In short, the relative numbers at starting of any two races which occupy the same country are comparatively unimportant, ethnologically speaking; what it really imports us to know is how fast or how slowly each of the two elements tends to increase. A constant supplanting of families by families is always going on—an absorption of one family by the other; and this often in a way that completely misleads us as to the true result. For, suppose a stock with a Norman name—call it De Montmorency—to settle down among a Saxon population, and, from generation to generation, to have one son only, who always marries a Saxon woman. At the fifth generation, there will still apparently be a De Montmorency, who will pass current with all of us for a genuine unadulterated Norman. But, in reality, though he traces in the direct line by heir male back to the original De Montmorency, he will have only $\frac{1}{32}$ of Norman blood, and $\frac{31}{32}$ of Saxon. Put a negro for the ancestor, and this truth will be immediately apparent. For the first generation will be a mulatto, the second will be a quadroon, the third an octaroon, and the fourth will so entirely have lost the traces of African descent as to be (in the old slave phrase) "white by law." Nobody on earth could possibly detect in the fifth remove the very slightest tinge of negro ancestry.

And this last example leads us up to the final point, to prove which I have ventured to adduce the imaginary case of Barataria. It seems to me that while historical data are in the very highest degree misleading (because we can never really ascertain for distant times the relative rates of increase), the one certainty upon which the ethnologist can repose is physical peculiarities. These, it has abundantly been shown, do really repeat themselves with great persistency, being truly characteristic of races and of their intermixture, even down to the very fractions of each involved. Nobody has any practical difficulty in distinguishing a mulatto from a negro or a white man; a quadroon from a mulatto; or an octaroon from a quadroon. One can say at once, "This man is a pure-blooded Chinaman; this one is half-Chinese and half-Malay; this one is Malay with a slight Chinese intermixture," and so forth. The physical peculiarities of both races persist in the hybrids; and when we find a remote hybrid (like our person of negro descent in the fifth degree) in whom one stock has completely overborne the other, it is because the remaining fraction of the weakest blood has been practically bred out. Such a person is, in fact, essentially a white man. In British ethnology (to take a home case) the differences of race are, of course, far less marked, but they are equally persistent; and the best way, therefore, to arrive at a just conception of what blood preponderates in our modern British people is not to follow the procedure of Professor Freeman and the historical school, but to follow that of Professor Huxley, Dr. Beddoes, and the scientific anthropologists. Look not at the ethnical composition of Britain in the ninth century, but at the skull and bones of the modern Englishman, compared with those of the purest discoverable old Celts and the purest discoverable old Teutons.

HER MAJESTY the Queen has accepted a copy of Mr. Fayle's new work entitled "The Spitalfields Genius; a Memoir of William Allen," who was the confidential friend, the trustee, and the executor of her Majesty's father.

MESSRS. HACHETTE & Co., of Paris, will publish very shortly a popular illustrated French editions of Dickens's works. The majority of the illustrations are those by Barnard, but every volume will contain a certain number of original designs by various English and foreign artists residing in England. M. Joseph Tonneau will supply the greater number of these.—*Athenæum.*

CHATS ABOUT GEOMETRICAL MEASUREMENT.

BY RICHARD A. PROCTOR.

(*Continued from p.* 383.)

A. But can we always get a neat set of chords, like A C, C D, D E, &c., in Fig. 3, or of tangent-lines like A H, H K, K L, &c., in the same figure, and so determine the length of our arc?

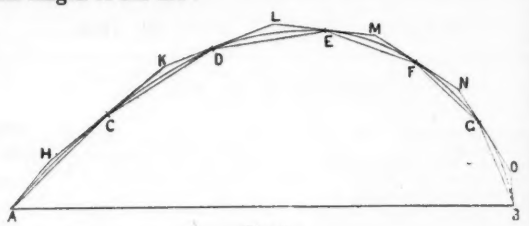


Fig. 3.

M. Unfortunately we cannot. We usually have to be content with another device, the consideration of which is of some importance, since it brings before us the true idea of tangent-lines. Indeed, I am not sure but that the measurement of direction at different points of a curve ought not to have been the first point to be considered. However, as we have been naturally brought to it along the line we have followed, we may take it now as well as earlier.

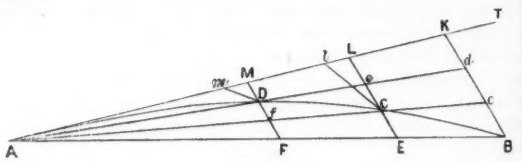


Fig. 6.

A. I am all attention.

M. 'Tis well. Let A D C B (Fig. 6), be a small part of some arc, A T the tangent at T. Join A B, A C, A D. Then it is clear that these lines lie nearer and nearer in direction to the tangent line A T. Moreover, since the curve has the direction A T at the point A, and changes *continuously* in direction from A to D, C, B, &c., it is evident that by taking points as C, D, and thence, along the curve, successively nearer and nearer to A, we get chords as A B, A C, A D, &c., drawing nearer and nearer in direction to the tangent A T, until they differ from it in direction by an angle less than any angle, however small, that can be indicated. The angle like B A T made between one of these chords and A T grows less and less up to nothing as the other end draws nearer and nearer to A, passing continuously through all values between the angle B A T with which it may be supposed to have begun, and the evanescent angle when the moving point merges into A.

A. All this is clear; but what this has to do with the measurement of the length of an arc I fail utterly to see.

M. Nay, did I say you *could* see the connection? But I think you will as I proceed.

A. Again, I am all attention.

M. Suppose now that from B, C, D a series of parallel lines are drawn making some finite angle B K T, C L T, D M T with A T; and produce the various lines as shown in Fig. 6. Then it is obvious that the ratios A B to A K, A C to A L, A D to A M draw nearer and nearer to equality as we take points B, C, D nearer and nearer to A.

They may not do so at the beginning of our approach, but they must do so to the end. For by similar figures these ratios are the same respectively as A B to A K, A c to A K, A d to A K; and eventually we get a line as A d but inclined to A T at an indefinitely small angle. Such a line would be actually equal to A K, so long as the angle B K T is finite. Hence such a ratio A B to A K becomes eventually one of equality when the point B is about to merge into A. Nor does it matter if the lines drawn from C and D, or have such positions as C l, D m,—that is make varying angles with A T,—so long as the angles B K T, C l L, D m M remain finite, no matter how small they may become, the ratio of the chord like A D to the part like A m cut off the tangent must eventually be one of equality. For a finite angle, however small, is infinitely greater than an evanescent angle. Thus from B, Fig. 7 on the line A B, let a line B K L be drawn making a very small but still a finite angle L B A with A B; then it is manifest that if an

Fig. 7.

indefinite line A T be turned round the point A B (in the plane of the figure) till it coincides with A B, the point of intersection K will move up to and eventually coincide with B, no matter how small the angle L K B: that is A K, and A B will eventually be equal,—just as A T, in its motion around A, is merging into A B.

A. Now tell me how this helps us.

M. Why, instead of the chord A B in Fig. 6, we may take A K, a part of the tangent cut off by any line such as B K making a finite angle (*let it be what it may*) with the tangent A T.

A. Can you illustrate the advantage of this?

M. In other words, can I show how the length of a curved arc may be obtained, in some given instance, by this method? I can; and much more readily than by taking chords or tangents fitting round the curve as in Fig. 3.

A. Will you begin with the arc of an ellipse?

M. Not quite.

A. And why not?

M. Simply because the case is too difficult. I will begin with the arc of a cycloid.

A. I thought the cycloid was a curve of higher order than the ellipse.

M. So it is. In fact, it is of infinitely higher order, since, if expressed in the form of an equation between x and y, the powers of these variables would be infinite. But that need not concern us. It happens that the arc can be easily obtained by a geometrical method.

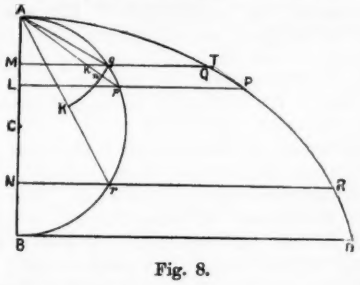


Fig. 8.

A. To the charge, then!

M. Please observe that I am not going to do more, in this or any other case, than give such sufficient outline of the proof as may enable you to satisfy yourself that the relation dealt with is really demonstrable on the lines followed. You must fill in details for yourself.

A. I will endeavour so to do.

M. Let A P D be a half cycloid, A B its axis, A q p B half the generating circle. Through P, Q, two neighbouring points on the cycloid, draw P p L, T Q q k M. Join A q; draw A k n p; the tangent P T; and the arc q n round A as centre. Then, by a known property of the cycloid, T P is parallel and equal to k p; q n is eventually perp. to A p, when Q comes close up to P; and triangle q p k is eventually isosceles ($\angle q k p = \angle k p L = \angle q p k$, standing eventually on equal arc); hence $k n = n p$; or $k p$, *i.e.* P T $= 2 n p$. But P T is eventually equal to chord or to arc P Q since Q T is inclined at a finite angle to the tangent P T; and $n p$ is the excess of chord A p over chord A q. Thus if we suppose the arc of the cycloid measured from A, while as we take successively small increments of the arc (as we have just taken Q P) we keep on taking the chord of A q p B farther and farther towards B, (as we have just passed from the chord A q to the chord A p) the growth of the arc of the cycloid will always be double the growth of the chord from A, to advancing points along the semicircle A q p B. Since they start together from naught, then, the cycloidal arc must always be just double the corresponding chord. Thus,

Arc A Q P = 2 chord A p;

Arc A P D = 2 diameter A B;

And any arc Q P R = 2 K r, obtained by describing the circular arc q n K round A, to meet chord A r.

A. That is strange,—a curved arc like Q R equal to twice a straight line like K r, and that, too, in the case of such a curve as the cycloid!

M. Do you see any flaw in the proof?

A. No; except that when P is very near A it can hardly be said that the angle between P T and Q T is finite.

M. You are right. But consider how much or how little this affects our result. It amounts merely to this, that for an indefinitely small part of the arc A P D, near A, our proof fails; that is, for a portion of this arc near A, which may be made less than any distance which can be assigned, the proof fails,—which is as much as to say that it does not fail at all.

(To be continued.)

THE CHEMISTRY OF COOKERY.

By W. Mattieu Williams.

XLVII.—THE COLOURING OF WINE.

SOME years ago, while resident in Birmingham, an enterprising manufacturing druggist consulted me on a practical difficulty which he was unable to solve. He had succeeded in producing a very fine claret (Château Digbeth, let us call it) by duly fortifying with silent spirit a solution of cream of tartar, and flavouring this with a small quantity of orris root. Tasted in the dark it was all that could be desired for introducing a new industry to Birmingham; but the wine was white, and every colouring material that he had tried producing the required tint marred the flavour and bouquet of the pure Château Digbeth. He might have used one of the magenta dyes, but as these were prepared by boiling aniline over dry arsenic acid, and my Birmingham friend was burdened with a conscience, he refrained from thus applying one of the recent triumphs of chemical science.

This was previous to the invasion of France by the phylloxera. During the early period of that visitation, French enterprise being more powerfully stimulated and

less scrupulous than that of Birmingham, made use of the aniline dyes for colouring spurious claret to such an extent that the French Government interfered, and a special test paper named Œnokrine was invented by MM. Lainville and Roy, and sold in Paris for the purpose of detecting falsely-coloured wines. The mode of using the Œnokrine was as follows:—"A slip of the paper is steeped in pure wine for about five seconds, briskly shaken, in order to remove excess of liquid, and then placed on a sheet of white paper to serve as a standard. A second slip of the test-paper is then steeped in the suspected wine in the same manner, and laid beside the former. It is asserted that 1-100,000 of magenta is sufficient to give the paper a violet shade, whilst a larger quantity produces a carmine red." With genuine red wine the colour produced is a greyish blue, which becomes lead-coloured on drying. I copy the above from the *Quarterly Journal of Science* of April, 1877. The editor adds that the inventors of this paper have discovered a method of removing the magenta from wines without injuring their quality, "a fact of some importance, if it be true that several hundred thousand hectolitres of wine sophisticated with magenta are in the hands of the wine-merchants" (a hectolitre is=22 gallons).

Another simple test that was recommended at the time was to immerse a small wisp of raw silk in the suspected wine, keeping it there at a boiling heat for a few minutes. Aniline colours dye the silk permanently; the natural colour of the grape is easily washed out. I find on referring to the *Chemical News*, the *Journal of the Chemical Society*, the *Comptes Rendus*, and other scientific periodicals of the period of the phylloxera plague, such a multitude of methods for testing false colouring materials that I give up in despair my original intention of describing them in this paper. It would demand far more space than the subject deserves. I will, however, just name a few of the more harmless colouring adulterants that are stated to have been used, and for which special tests have been devised by French and German chemists:—

Beet-root, peach-wood, elderberries, mulberries, logwood, privet-berries, litmus, ammoniacal cochineal, Fernambucca-wood, phytolacca, burnt sugar, extract of rhatany, bilberries; "jerupiga" or "geropiga," a "compound of elder juice, brown sugar, grape juice, and crude Portuguese brandy" (for choice tawny port); "tincture of saffron, turmeric, or safflower" (for golden sherry); red poppies, mallow flowers, &c.

Those of my readers who have done anything in practical chemistry are well acquainted with blue and red litmus, and the general fact that such vegetable colours change from blue to red when exposed to an acid, and return to blue when the acid is overcome by an alkali. The colouring matter of the grape is one of these. Mulder and Maumené have given it the name of *œnocyan* or *wine blue*, as its colour, when neutral, is blue; the red colour of genuine wines is due to the presence of tartaric and acetic acid acting upon the wine blue. There are a few purple wines, their colour being due to unusual absence of acid. The original vintage which gave celebrity to port wine is an example of this.

The bouquet of wine is usually described as due to the presence of ether, *œnanthic* ether, which is naturally formed during the fermentation of grape juice, and is itself a variable mixture of other ethers, such as caprilic, caproic, &c. The oil of the seed of the grape contributes to the bouquet. The fancy values of fancy wines are largely due, or more properly speaking *were* largely due, to peculiarities of bouquet. These peculiar wines became costly because their supply was limited, only a certain vineyard, in some cases of very small area, producing the whole crop of the fancy article. The high price once established, and the demand far exceeding the possibilities of supply from the original source, other and resembling wines are sold under the name of the celebrated locality with the bouquet or *a* bouquet artificially introduced. It has thus come about in the ordinary course of business that the dearest wines of the choicest brands are those which are the most likely to be sophisticated. The flavouring of wine, the imparting of delicate bouquet, is a high art, and is costly. It is only upon high-priced wines that such costly operations can be practised. Simple ordinary grape-juice—as I have already stated—is so cheap when and where its quality is the highest, *i.e.*, in good seasons and suitable climates, that adulteration with anything but water renders the adulterated product more costly than the genuine. When there is a good vintage it does not pay even to add sugar and water to the marc or residue, and press this a second time. It is more profitable to use it for making inferior brandy, or wine oil, *huile de marc*, or even for fodder or manure.

This, however, only applies where the demand is for simple genuine wine, a demand almost unknown in England, where connoisseurs abound who pass their glasses horizontally under their noses, hold them up to the light to look for beeswings and absurd transparency, knowingly examine the brand on the cork, and otherwise offer themselves as willing dupes to be pecuniarily immolated on the great high altar of the holy shrine of costly humbug.

Some years ago I was at Frankfort, on my way to the Tyrol and Venice, and there saw, at a few paces before me, an unquestionable Englishman, with an ill-slung knapsack. I spoke to him, earned his gratitude at once by showing him how to dispense with that knapsack abomination, the breast strap. We chummed, and put up at a genuine German hostelry of my selection, the Gasthaus zum Schwanen. Here we supped with a multitude of natives, to the great amusement of my new friend, who had hitherto halted at hotels devised for Englishmen. The handmaiden served us with wine in tumblers, and we both pronounced it excellent. My new friend was enthusiastic; the bouquet was superior to anything he had ever met with before, and if it could only be fined—it was not by any means bright—it would be invaluable. He then took me into his confidence. He was in the wine trade, assisting in his father's business; the "governor" had told him to look out in the course of his travels, as there were obscure vineyards here and there producing very choice wines that might be contracted for at very low prices. This was one of them; here was good business. If I would help him to learn all about it, presentation cases of wine should be poured upon me for ever after.

I accordingly asked the handmaiden, "Was für Wein?" &c. Her answer was, "Apfel Wein." She was frightened at my burst of laughter, and the young wine-merchant also imagined that he had made acquaintance with a lunatic, until I translated the answer, and told him that we had been drinking cider. We called for more, and recognised the "curious" bouquet at once.

The manufacture of bouquets has made great progress of late, and they are much cheaper than formerly. Their chief source is coal-tar, the refuse from gas-works. That most easily produced is the essence of bitter almonds, which supplies a "nutty" flavour and bouquet. Anybody may make it by simply adding benzol (the most volatile portion of the coal-tar), in small portions at a time, to warm, fuming nitric acid. On cooling and diluting the mixture, a yellow oil, which solidifies at a little above the freezing-point of water, is formed. It may be purified by washing first with water, and then with a weak solution

of carbonate of soda to remove the excess of acid. It is now largely used in flavouring as essence of bitter almonds. Its old perfumery name was Essence of Mirbane.

By more elaborate operations on the coal-tar product, a number of other essences and bouquets of curiously imitative character are produced; one of the most familiar of these is the essence of jargonelle pears, which flavours the "pear drops" of the confectioner so cunningly; another is raspberry flavour, by the aid of which a mixture of fig-seeds and apple-pulp, duly coloured, may be converted into a raspberry jam that would deceive our Prime Minister. I do not say that it now is so used, though I believe it has been, for the simple reason that wholesale jam-makers now grow their own fruit so cheaply that the genuine article costs no more than the sham. Raspberries can be grown and gathered at a cost of about twopence per pound.

With wine at 60s. to 100s. per dozen the case is different. This price leaves an ample margin for the conversion of "Italian reds," Catalans, and other sound, ordinary wines into any fancy brands that may happen to be in fashion. Such being the case, the mere fact that certain emperors or potentates have bought up the whole produce of the château that is named on the labels does not interfere with the market supply, which is strictly regulated by the demand.

Visiting a friend in the trade, he offered me a glass of the wine that he drank himself when at home, and supplied to his own family. He asked my opinion of it. I told him that I thought it was genuine grape juice, resembling that which I had been accustomed to drink at country inns in the Coté d'Or (Burgundy) and in Italy. He told me that he imported it directly from a district near to that I first named, and could supply it at 12s. per dozen with a fair profit. Afterwards, when calling at his place of business in the West-end, he told me that one of his best customers had just been tasting the various dinner wines then remaining on the table, some of them expensive, and that he had chosen the same as I had, but what was my friend to do? Had he quoted 12s. per dozen, he would have lost one of his best customers, and sacrificed his reputation as a high-class wine-merchant; therefore he quoted 54s., and both buyer and seller were perfectly satisfied: the wine-merchant made a large profit, and the customer obtained what he demanded—a good wine at a "respectable price." He could not insult his friends by putting cheap 12s. trash on *his* table.

Here arises an ethical question. Was the wine-merchant justified in making this charge under the circumstances; or, otherwise stated, who was to blame for the crookedness of the transaction? I say the customer; my verdict is, "Sarve him right!"

In reference to wines, and still more to cigars, and some other useless luxuries, the typical Englishman is a victim to a prevalent commercial superstition. He blindly assumes that price must necessarily represent quality, and therefore shuts his eyes and opens his mouth to swallow anything with complete satisfaction, provided that he pays a good price for it at a respectable establishment, *i.e.*, one where only high-priced articles are sold.

If any reader thinks I speak too strongly, let him ascertain the market price per lb. of the best Havanna tobacco-leaves where they are grown, also the cost of twisting them into cigar shape (a skilful workwoman can make a thousand in a day), then add to the sum of these the cost of packing, carriage, and duty. He will be rather astonished at the result of this arithmetical problem.

If these things were necessaries of life, or contributed in any degree or manner to human welfare, I should protest indignantly; but seeing what they are and what they do, I rather rejoice at the limitation of consumption effected by their fancy prices.

THE EXPLOSIVENESS OF COAL-DUST.

IT is the special merit of Mr. William Galloway, formerly Government Inspector of Mines, now director of the Dinas Colliery, near Cardiff, in South Wales, that he drew the attention of mining engineers to the great danger of dry coal-dust in fiery coal-mines, owing to its explosiveness, in a paper, "Influence of Coal-dust in Colliery Explosions," read before the Royal Society of London in 1879. Although its influence was already presumed by Faraday and Lyell in 1844, after an explosion in the Haswell Colliery, and also proved to have existed at explosions in mines near Firminy and Villars in 1855 and 1867, by M. du Souich in France, it is to Mr. Galloway the credit is due of having first demonstrated its action experimentally. These experiments were later on repeated by the British Commission on Colliery Explosions, the results corroborating Mr. Galloway's views. As the opinions of some French mining engineers and of the French "Commission sur les Explosions du Grison" did not seem to tally with the English experiments, the Prussian Government Commission on Colliery Explosions deemed it desirable to have these experiments repeated on a large scale and under conditions which would be identical with those existing in fiery coal-mines.

Thus, at the instance of one of its members, Director Hilt, of Aachen, the scientific technical committee of the Government Commission decided upon erecting an experimental arrangement for this purpose at the Government colliery "Kœnig" at Neunkirchen, near Saarbrücken, where natural fire-damp could be drawn in any quantity from a "blower," by which the explosive gas escapes in the mine from a bed of conglomerate.

At this mine, in an old burrow of stones, an adit level was constructed under the special superintendence of Mine-inspector Margraf. From its mouth to the head it has a length of 167 ft., and it is timbered with elliptical rings of double ⊤ iron and lined inside with a layer of 2-in. pine planks, which are tightly jointed. On one side this structure is entirely buried up to the top in the old burrow, while on the other its upper quarter is visible, and is provided with thirty small windows of thick glass well fixed in cast-iron frames. The head of this adit level is formed by a heavy block of masonry, 12 ft. 4 in. long and 9 ft. 10 in. wide, forming there a niche or recess 3 ft. 10 in. deep. In this masonry seven small cast-iron mortar guns, whose bores represent ordinary blast-holes, are well fixed in such a manner that two are close under the roof, three in the middle of the head, and two somewhat above the floor. The direction of their respective axes is such, that the upper guns converge so as to cut the floor 10 mètres from the head, while the axes of the lower guns cut the roof at the same distance; the three middle guns, however, converge so that their axes hit the middle of the floor at 5 mètres from the head. The inner end of the adit level is provided with stout wooden frames, between which sailcloth can be fastened, so as to form a series of chambers, of which the innermost has a cubic space of about 20 cubic mètres (706·3 cubic feet). The firing of the guns is effected by electricity, in order to produce an explosion of either firedamp or coal-dust, or of both, and during the last couple of months over 200 of such artificial mine explosions have taken place.

On October 3 the trials were made with powder charges of 8 oz., these charges being 12 in. in length, and being covered with a 19½ in. tamping of clay or small coal. A gun fired with clay tamping gave a length of flame of 10 ft., with small coal tamping of 26 ft., as could be observed through the windows. Then the floor was covered for 131 ft. with a layer of coal-dust 1½ in. thick, derived from poor coal from the Union mines of Horsbach, near Aachen. When the guns were fired under these conditions with clay tamping, the flames became 18 ft., and with small coal tamping 31 ft. in length. After this bituminous coal-dust from Pluto mine in Westphalia was placed in a like manner upon the floor and fired at, when a heavy explosion occurred, the flame rushing forth 23 ft. from the mouth of the adit level and thus reaching a total length of 190 ft. from the head, and that without presence of any firedamp. A repetition of this trial gave a like result.

The experiments with fire-damp followed next. The carburetted hydrogen gas was taken from a blower in the mine, 394 ft. below the surface above the Grolmann seam from a coarse conglomerate, and conveyed in a pipe 3,608 ft. long to a gasholder on the surface, whence it could be forced at will into the experimenting chambers of the adit level. A mixture of air with 5 per cent. gas fired at in the 20 cubic mètre chamber with clay tamping, showed a length of flame of 36 ft. The same mixture, with a layer of coal-dust of only 65½ ft. length, gave with clay tamping a very heavy explosion with a flame of 171 ft. long, and much heavy after-damp. The violence of these explosions may be gathered from the fact, that when coal-dust from the Pluto mine, without any trace of fire-damp in the adit, was fired at an iron tub or coal-wagon, weighing nearly 6 cwt., and standing outside before the adit mouth upon a pair of rails rising 4 degs., was pushed on for 24 ft., and when fired with fire-damp as above it was lifted from the rails and thrown a distance of 39 ft. In a siding level a solid brattice work, 2 in. in thickness, was entirely broken by the shock of the Pluto dust explosion alone, and when rebuilt and fired at with dust and fire-damp it was not only broken, but thrown a distance of 98 ft.

It is to be hoped that these interesting trials, conducted under conditions which enable experiments to be made without danger, may be continued with all possible variations, and that they may yield results, from which all concerned in coal-mining may derive benefit and complete immunity from such explosions as are under investigation. —*Engineering.*

THE EARTH'S SHAPE AND MOTIONS.

By Richard A. Proctor.

CHAPTER V.—THE EARTH'S ROTATION.

(*Continued from page* 360.)

THE general principles on which the properties of the gyroscope depend are sufficiently simple, though the theory of rotating bodies is one of the most difficult subjects in the whole range of mathematical inquiry. Newton himself shrank from attacking it, where, in dealing with the phenomena of precession and nutation, he found it directly involved. He preferred to regard the protuberant mass of the earth's equatorial regions as a collection of bodies travelling around the earth, and to consider the influence of external attraction on the orbital motions of those bodies; and then having found that such and such changes would be produced, he showed how far those changes would be modified when the bodies, being rigidly attached to the earth, had to force her, so far as they could, to participate in their peculiarities of motion. And even modern mathematics, despite the wonderful power which it gives us over the problems we have to deal with in discussing the motions of the planets, yet leaves the problem of rotating bodies one of enormous intricacy and difficulty.

However, for our present purpose, all that is necessary is that we should understand the general principles on which the theory of the gyroscope depends.

First of all we must remember that the figure of the rotating disc has nothing to do with the observed phenomena. A rotating sphere would exhibit them quite as well, although there are reasons of convenience which render the disc preferable.

Secondly, we must dismiss the notion that gravitation is primarily involved in the observed phenomena. Gravity is a force conveniently applicable to exhibit the peculiarities of the gyroscope, but any other force will serve equally well.

The fundamental property on which all the phenomena exhibited by the gyroscope depend is simply this—that when a body is rotating upon an axis, that axis tends to maintain itself unchanged in *direction*, though free to take up a new position *parallel* to itself. Upon the speed of rotation, and the mass of the rotating body, depend the force with which the axis tends to maintain its direction unchanged; but let the body be ever so small and its rotation ever so slow, *some* force is always required to change the direction of the axis of rotation.*

Now, it is not difficult to show that this peculiarity is merely an expression of the fact that when a body is moving in a given direction, it cannot be made to move in a different direction without an expenditure of force proportioned to the mass of the body and the velocity of its motion.

Let me explain clearly how I mean this to be taken.

If a body moves in the direction A B (Fig. 1), and we wish it to move in the direction A C, we may effect this by giving it an impulse in direction A D, such that it would move from A to D under that impulse in the same time as it would take in moving from A to B if untouched. If it was moving very fast at first, it would of course traverse A B in a very short time, and we must give a very sharp impulse, because we are to force on this body a proportionately rapid motion in the direction A D. Had the body been moving slowly towards B, a slighter impulse would effect our purpose; but even then, some impulse would of course be required.

Fig. 1.

Now, if we consider how the different points in a rotating mass are severally moving, we shall see why it is that we find it so difficult to shift the axis of a gyroscope, when the disc is in rapid rotation.

Let A B C D (Fig. 2) be the circle described by any particle of the rotating disc, about the axis E E′; and suppose we want to shift the axis to the position *e e′*. This is equivalent to making the particle travel in the circle *a* B *c* D. Now at *a* and *c*, the particle would be travelling in the same direction as before the change, so that no difficulty arises here. But at the common points B and D of the two circles, a distinct change of direction has to be

* Foucault's pendulum experiments are in reality merely a case of this great property, since a pendulum in swing is rotating about a definite axis; and if the whole change of position in the supporting frame could be effected at the very instant when the pendulum is at the limit of a swing, undoubtedly the pendulum would partake in the change of place.

effected. The particle, which, starting from B, would have gone in direction B T, must be solicited to travel in direction B *t*. Now, if we could impart to the particle at the very moment it reached B, a certain force, in the direction towards the plane of the paper (that is, from the observer), it would (neglecting all consideration of its attachment to the rest of the disc) proceed to move in the direction B *t*.

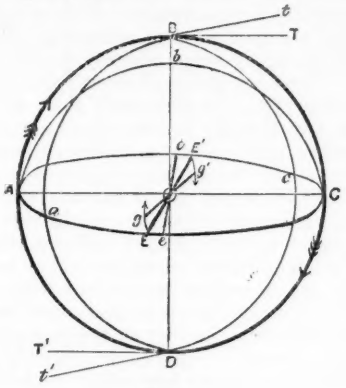


Fig. 2.

At D the particle would require an exactly opposite treatment, in order to be made to move in the direction D *t'*. As a matter of fact, however, the particle being rigidly attached to the rest of the disc, we have to consider what forces must be applied in order to change the position of the plane of motion A B C D to the position *a* B *c* D.

The natural idea would be to try to move the disc bodily round the axis B D so as to shift the point A to *a*, the point C to *c*, and therewith the axis E E' to the position *e e'*. But so soon as this is attempted a resistance is experienced, and a movement in a direction not desired results, as though the disc A B C D had been shifted round the axis, A C E being carried *down* and E' *up*. A little consideration shows why this is. We have not applied forces of the right sort to the particles of the rotating disc. We have tried to shift the direction of motion at A and C, where no change is required, while we have applied no force at all at B and D, where the change in the direction of motion is to be greatest. While the part near E goes down and the part near E' up, is also clear. Since we try to move A towards E, while its motion of rotation is carrying it towards B; it naturally takes a direction of rotation towards some point on the arc B E, in other words the plane of motion A B C tends to assume such a position as A *b* C.

Let us, then, instead of following the seemingly natural course in this matter, inquire what we really want, and so let reason guide us to the right course of action.*

We want the point B to change its direction from B T to B *t*: manifestly, then, B must be thrust *from* us (as we look at Fig. 2). Clearly any other points as F and *f* on the semicircle A B C must also receive an impulse in the same direction, but with less energy the nearer they lie to A or C. Obviously, then, we shall be giving the right sort of impulse to all the particles along the arc A B C if we try to turn the ring of particles A B C D round the axis A C, thrusting the part A B C from us (as we look at the figure) around A C. It is equally obvious that the same action—by which we bring the part A D C towards us—will give the required directions and degrees of impulse to the particles along the semicircle A D C. This, then, manifestly is what we have to do:—

To make the disc A B *c* D, rotating in the direction A B C D round the axis E E', assume the position *a* B *c* D, rotating round the axis *e e'*, we must act on it as if trying to turn it around the axis A C, to bring the axis E E' to such a position as *g g'*.

If we consider a little, we shall see why the effect which, were the rotating ring at rest, would be produced at B and D—B moving from, and D towards, the eye—is not produced when the ring of particles is rotating. B is moving towards T with greater or less rapidity, according to the rate of rotation, but always with *some* velocity while the rotation lasts. Now this being the case, nothing short of an infinite impulse applied to B at right angles to B T, would make it move off at right angles to B T; for the motion in direction B T must always produce *some* effect. As a matter of fact, while the velocity of rotation is very rapid, the impulse actually applied to a particle momentarily at B, to make it move in direction square to B T, is quite small compared with that which would be required to make the particle move as fast in *that* direction as it is actually moving in direction B T. Hence the tendency to motion at B in the direction of this impulse is slight compared with the motion already existing in the direction B T.

(To be continued.)

* So far as I know, this way of viewing the problem of the gyroscope has not been hitherto adopted. It seems to me far the best for making as clear as possible this not very difficult but still not altogether obvious subject.

THE ENTOMOLOGY OF A POND.

By E. A. Butler.

ABOVE THE SURFACE—(*continued*).

THE *Perlidæ* are four-winged creatures of a brownish or yellowish tint; the wings are a good deal longer than the body, and when folded, lie flat along the back, overlapping one another, and, of course, extending some distance beyond the extremity of the abdomen. They are interesting from a developmental point of view, since they manifest more clearly than any other insects we have yet had to do with, the composite character of the thorax. In all insects, the thorax, in reality, consists of three segments succeeding one another in longitudinal row, and called, respectively, in order of position, prothorax, mesothorax, and metathorax, the prefixes signifying front, middle, and hinder. It is is always the prothorax that carries the first pair of legs, the mesothorax the second pair of legs and the first pair of wings, and the metathorax the third pair of legs and the second pair of wings. In most cases, one or other of these segments is developed, at least on the upper side, to a far greater extent than the rest, and so occupies a large proportion of the thoracic region; but it is not always the same part that is thus enlarged at the expense of the rest. In beetles and bugs, what is commonly called the thorax really consists simply of the first thoracic segment, though a portion of the second is visible behind this as the triangular piece called "scutellum," which in some bugs is developed to so enormous an extent as to cover the whole abdomen; in the two-winged flies the middle region preponderates, as being that which carries the only pair of wings; in bees, ichneumon flies, butterflies and moths, or, in other words, in the Hymenoptera and Lepidoptera, the meso- and metathorax occupy most of the space, the prothorax being reduced to very minute dimensions. The caddis flies show all three parts, though still the prothorax is small when compared with

the other segments, but in the *Perlidæ* (and this is a point which will help to distinguish them from caddis flies) all three segments are very plainly visible, the prothorax being quite as large as the other parts; and, in fact, when compared with most other insects, a stone fly seems as though it had three distinct thoraxes. This separateness of the thoracic segments, taken together with the rudimentary condition of the mouth organs, and the fact that no quiescent pupa stage intervenes between the larva and perfect insect, indicates lowness of type.

The fore-wings are long and narrow, but the hind pair broader and more nearly triangular. In most insects the points of attachment of both pairs of wings to the thorax are, in consequence of the fusion of the thoracic segments, closely approximated; but in the *Perlidæ* this is naturally not the case, and the wings at their bases not only do not overlap, but are separated by a considerable interval, an arrangement that suggests the idea of parts of two different insects having been joined to make the complete creature.

In their larval form, most of the *Perlidæ* prefer swiftly-running streams, at the bottom of which they conceal themselves under stones, &c. Like the caddis flies, the female carries her eggs for a time at the end of the abdomen, as a little black globular bundle. The larvæ are very similar in shape to the adult insects, minus wings, and, unlike the caddis worms, do not construct cases for defence. They are carnivorous, preying upon the larvæ of may-flies and other aquatic insects, but, notwithstanding this, they are neither particularly active, nor endowed with remarkably good offensive weapons. They therefore secure their prey by the expedient of ambuscade, lurking behind stones or pond-weeds in order to surprise their victims, and even sometimes throwing a little mud over themselves, in order to render their concealment the more effectual. This latter habit is practised principally by those whose bright colour would otherwise render them too conspicuous on the dingy muddy bottom which forms their hunting-ground. The pupa resembles the larva, except that it shows traces of wings When the time comes for its final change, it leaves the water and wanders about in the neighbourhood till it finds a place suitable for its disrobement; such a spot will be the surface of a rock, or any other material that, by its roughness, affords a good foothold, without which it would be unable to extract its limbs from their encasing skin. Having chosen the site, it takes a good grip of the irregularities of the surface, by means of its tiny claws, and then, as with so many other insects, the skin splits along the back of the neck, and the fully-formed being, which has already become loosened from its skin by the passage of air under the latter, gradually extricates itself from its investing pellicle.

The flight of a stone-fly is heavy and direct, the weakness of its wings preventing it from being able to "cut capers" in the air. The slightest touch is sufficient to arrest its flight and precipitate it to the ground. But this is no great disadvantage, for its winged life is of short duration, lasting only a few days, the rudimentary character of the mouth organs rendering the taking of nourishment impossible. Fig. 1 represents one of the commonest of our British stone-flies, and one, too, which inhabits stagnant water as well as running streams. It is sometimes called the willow-fly.

Fig. 1.—Nemoura variegata.

The Alder-fly or Orl-fly is called *Sialis lutaria*. It belongs to quite a different group from the preceding insect, viz., the Neuroptera Planipennia, a section containing about fifty British species. It is a lazy, blackish creature, with a large number of extremely thick and dark nervures on its smoky wings, whereby it may at once be recognised. There are plenty of insects with as many and even more nervures, but none with them so thick and conspicuous. In May the flies are often to be seen in prodigious numbers, sitting about on palings, stones, &c., near a pond. The female deposits an enormous number of eggs, which she is said to lay one by one on rushes or other aquatic plants; they are attached side by side with great regularity, and may be recognised by being terminated at the top by a little pointed projection. They are generally deposited in the immediate vicinity of water, but occasionally at a distance therefrom that must necessitate a considerable terrestrial journey on the part of the newly-hatched larva before it can become properly domiciled. The larva has its respiratory appendages reduced to slender filaments; seven or eight pairs are attached to the sides of the abdomen, and by their rowing motion the creature propels itself. At the close of its preliminary stages, it quits the water, and, unlike the stone-flies, burrows in the neighbouring bank, and forms a cell in which to pupate. The pupa, though incapable of transporting itself from place to place, yet has considerable powers of movement, and vigorously twists its tail about when disturbed.

Fig. 2.—Fore-wing of Sialis lutaria (A) and S. fuliginosa (B).

There are but two British species in the genus Sialis. They are very much alike, and would be undistinguishable to any but the expert, who knows just what differences to look for. Mr. McLachlan has pointed out that there is one little nervure in the fore-wings (Fig. 2 *a*), the position of which, relatively to the surrounding ones, varies in the two species; but is so constant in each as to afford the easiest way of distinguishing them. Of course, this is not the only difference, or it could scarcely justify the separation of the species, but the others are less easy of recognition.

(To be continued.)

AUTOMATIC VENTILATION, SO-CALLED.

NOW that the question of the public health, and all matters appertaining thereto, are being brought into such great prominence, it may, perhaps, not be uninteresting to our readers if we attempt to dispel the "magic halo" with which would-be sanitary experts endeavour to obscure the actions of some of the chief agents concerned in automatic ventilation. In so doing, and even if we have occasion to allude to the various physical laws which regulate the results obtained from systems of automatic ventilation, we shall endeavour to keep always before us our watch-word, "Science plainly worded, exactly described."

The three chief agents to which we wish to call attention are :—I. The wind. II. The law of "diffusion of gases." III. The movements of the atmosphere caused by columns of air of unequal weights.

I. *The Wind.*—Perhaps the agent which may, *par excellence*, be said to regulate all our endeavours to ventilate our houses, public buildings, house-drains, *et hoc genus omne*, is that very uncertain customer, the wind; and since the movements in the atmosphere which are due to the force of the wind cannot be perceived directly, it will be best to fall back on some simile in order to establish a basis on which to found our subsequent remarks.

Doubtless, each of our readers has, at one time or another, been standing on the platform of a station when an express train has rushed by, and will probably have noticed how every light particle in the vicinity was sucked in towards the path of the rapidly-moving train. Now, the *raison d'être* of this suction is simply this: Before the approach of the train, a given body of air was occupying a certain place, the train rushes on, and (pushing before it that body of air) occupies (temporarily) its place. After the passage of the train more air rushes in, dragging with it all light particles near, to fill the place vacated, else there would be a vacuum or, in other words, a space containing nothing.

The wind acts very much in the same way. A moving body of air sets in motion all the air in its immediate vicinity; it drives air before it, and at the same time causes a partial vacuum on either side of its path, towards which all air in the vicinity flows at (or nearly at) right angles. Here is the advantage to be reaped from the wind as a ventilating agent, but, as we shall see presently, this uncertain ally has also evil propensities, which must be guarded against.

The wind, then, blowing over the roofs of our houses, causes a current up our chimneys and ventilating shafts at right angles to the direction in which it blows. Thus we are able to form a very useful alliance with this natural force, if we, at the same time, can only manage to keep the upper hand!

Sometimes the wind, however, may impede ventilation by obstructing the exit of the "induced current" from any particular opening, or by blowing down any chimney or ventilating shaft. This is, indeed, one reason of our failing so often in obtaining an efficient system of ventilation—all may go well in a still atmosphere, but the pressure of the wind has not been taken into account.* We are, in a measure, indebted to Mr. Sampson Low, B.A., F.R. Met. Soc., for showing the plan to be adopted in order to make the utmost use of the wind as a ventilating agent, and at the same time guarding against its ill effects. Mr. Low has constructed a "ventilator" or ventilating head, which, while affording the wind a free passage over the orifice from which it is intended to extract the air, prevents any downward wind-pressure on that orifice. The accompanying diagram of this instrument may enable our readers to more readily understand the following brief description. The ventilator consists of three essential parts—the "shaft," to which is fixed the dome-shaped "wind-chest," and the "cap," which surmounts the whole structure.

Now the "dome" and the cap are fixed on to one another in such relative positions that at whatever angle the wind strikes the dome, its upward curves direct the current straight across the "extracting orifice," situated in the dome of the ventilator.

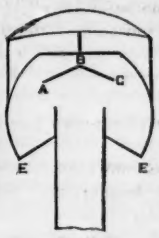
Perhaps the most remarkable feature of this instrument is the fact that if the wind strikes down vertically on the cap, an exhaust current within the shaft is in the same way set up. Though we say that this is "remarkable," yet we think our readers will see at once the simplicity of the principle involved, if they will but bear in mind our simile of the "railway train"

The apparatus may be examined at Messrs. Sharp & Co.'s establishment, 11, Holborn-circus, London.

Passing from our discussion of the wind and Mr. Low's ventilator, we come to other factors in this scheme of ventilation, without due attention to which, we venture to say, not even Mr. Low's patent nor the vendors' *exploitation* thereof will be found a very great success.

Concerning the diffusion of gases, it may be stated that every gas diffuses (that is to say, tends to become intimately mixed with another) at a certain specified rate—viz., at a rate "inversely proportional to the square root of its density," or, to translate that somewhat high-sounding phrase into plain English, we may state this stupendous fact thus: "Four volumes of the gas hydrogen will diffuse through a porous partition in the same time that it takes one volume of the gas oxygen to do so, oxygen being sixteen times heavier than hydrogen."

Elevation.



Section.

From this it will be seen that there is a constant escape of any foreign gas into the surrounding atmosphere. "This diffusing tendency is so great as to obtain even through brick and stone in every room that is not air-tight" (Pettenkofer). The amount of purification thus obtained is, however, for all practical purposes *nil*; and, moreover, organic substances are not affected by it. It is, therefore, only to be regarded as a subordinate factor in ventilation.

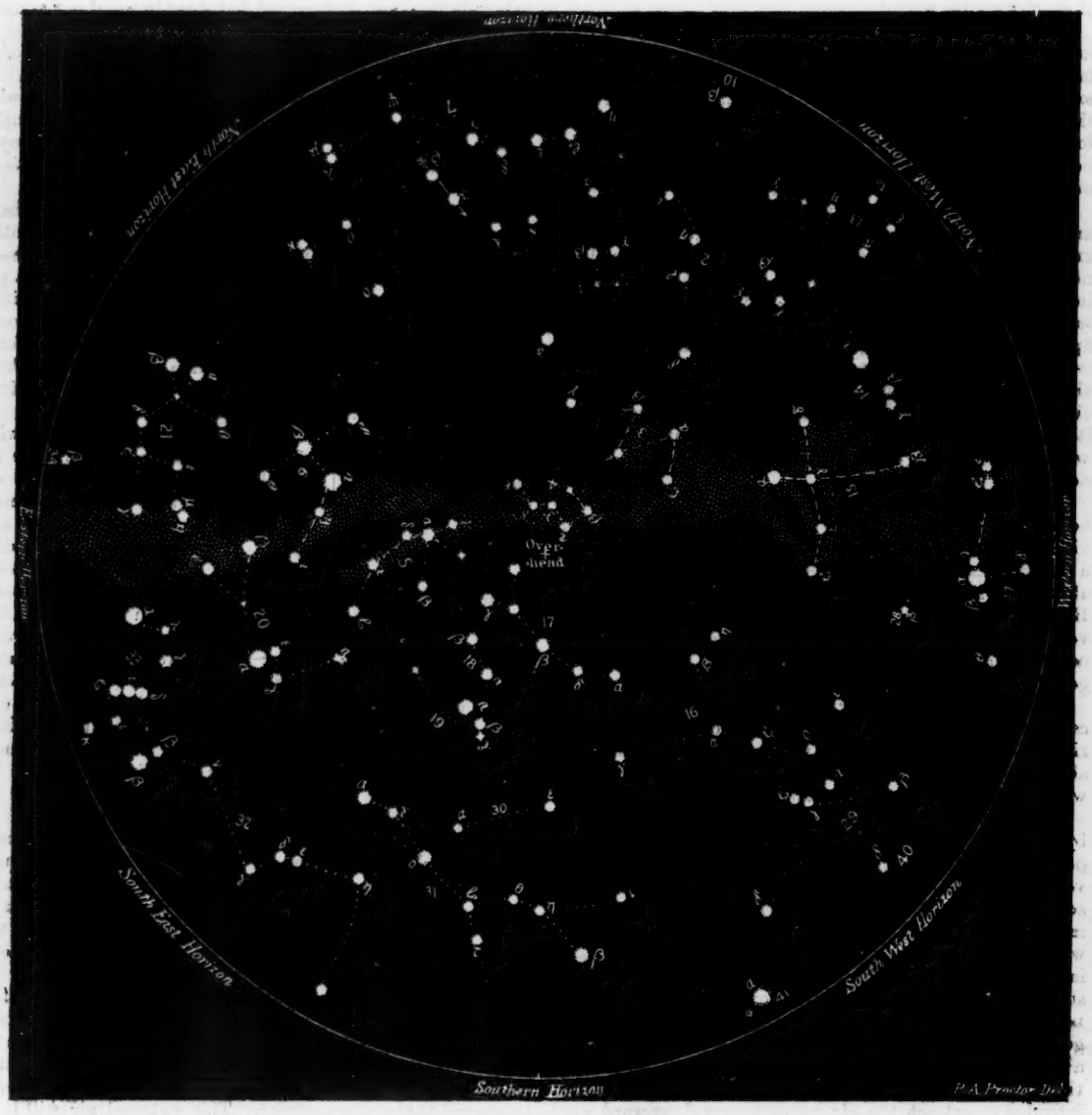
With reference to movements produced by columns of air of unequal weights, it may be said that we have a very important agent to assist us if we will (and to hinder us if we "won't"!), in devising an efficient scheme of ventilation. If the air in a room is heated by the presence of a fire or animal life, or if it be impregnated with moisture, such air will expand; and, if there be any outlet, a portion of it will escape, and that which remains behind will be lighter than an equal volume of the air external to the compartment. This external air will then rush in through every orifice until "equilibrium" is re-established. But, as the fresh air which comes in gets heated, it likewise expands and escapes, and there is, therefore, a constant stream of air coursing through the compartment.

From the above considerations, we think it will be apparent to our readers (we are, be it understood, treating merely of cases where the external air is colder than the air in the room) that there are, so to speak, two chief forces concerned in the removal of vitiated air from our rooms or buildings. They are the *vis a fronte*, or the suction-power which the wind exerts by passing over our chimneys or ventilating-shafts, and the *vis a tergo*, or the expansion and consequent ascension of the gases within the room, aided, to some extent, by that property of "diffusion" on which we have touched. There is one other agent which we have not as yet alluded to, but it is one to which Messrs. Sharp

* This pressure has been known to vary from one ounce to one pound, as the rate of the wind varies from three and a half miles to fourteen miles per hour.

NIGHT SKY FOR NOVEMBER AND DECEMBER.

First Map of Pair.



Showing the heavens as they appear at the following hours :—

November 7 at 10 o'clock.	November 18 at 9¼ o'clock.	November 30 at 8½ o'clock.
November 10 at 9¾ o'clock.	November 22 at 9 o'clock.	December 4 at 8¼ o'clock.
November 14 at 9½ o'clock.	November 26 at 8¾ o'clock.	December 7 at 8 o'clock.

& Co. give great prominence in their system. Briefly it is known as the "Syphon Theory," which consists in the following: where a compartment has to be ventilated entirely from above (*e.g.*, on ship-board), the fresh air will descend the shorter shaft and the foul air will ascend the longer, but, from experiments which have from time to time been conducted, we should say this is modified by a variety of causes, and is true in extreme cases only. However, the importance of extracting the foul air from the highest available point in the room or building cannot be too much insisted on. In conclusion, we would earnestly ommend to the careful consideration of our readers the subject of ventilation, whether of houses or ships, not forgetting, however, those necessary evils, house-drains; and it is to be hoped that the few remarks which we have here offered may enable them to understand the *modus operandi* of the "Natural Ventilation" schemes at present before us.

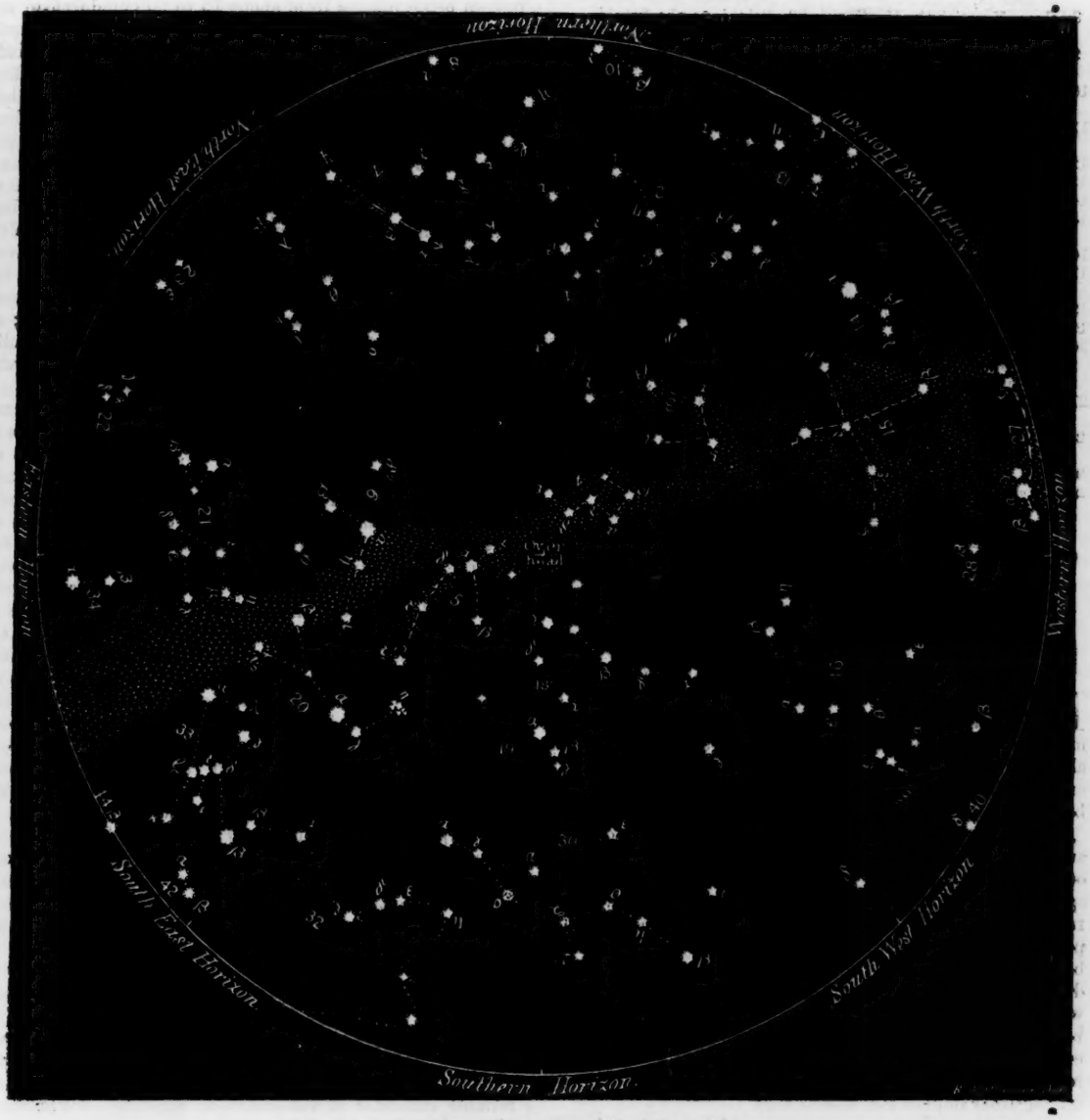
FIRST STAR LESSONS.

By Richard A. Proctor.

THE map of the stellar heavens, as presented this week, needs scarcely any explanation. It will be observed

NIGHT SKY FOR NOVEMBER AND DECEMBER.

Second Map of Pair.



Showing the heavens as they appear at the following hours:—

November 22 at 10 o'clock.	December 4 at 9¼ o'clock.	December 15 at 8½ o'clock.
November 26 at 9¾ o'clock.	December 7 at 9 o'clock.	December 19 at 8¼ o'clock.
November 30 at 9½ o'clock.	December 11 at 8¾ o'clock.	December 23 at 8 o'clock.

that the map has not, properly speaking, top, bottom, or sides; the centre represents the point overhead, the circumference marks the horizon. The stars of the first three magnitudes only are shown, and the constellations are numbered, not named. The numbering begins with the Little Bear, to see which in its proper position the map must, of course, be held with the "Northern Horizon" downwards. The other constellations are taken as nearly as possible in the order of their distance from the pole (*a* in 1 is the pole star), from Draco, the Dragon, which being nearest the polar constellation is numbered 2, to Argo, the Ship, which being the farthest from the pole of all those included in this series of maps is numbered 45, the last number in our list. The constellations are also taken around the pole in the order of their right ascension,—or in the direction in which the hands of a watch move, around the north pole, which in the southern skies means from right to left.

The constellations included in the set of maps are numbered throughout as follows:—

1. *Ursa Minor*, the *Little Bear* (*a*, the *Pole Star*).
2. *Draco*, the *Dragon* (*a*, *Thuban*)
3. *Cepheus*, *King Cepheus*.
4. *Cassiopeia*, the *Lady in the Chair*.
5. *Perseus*, the *Champion* (*β*, *Algol*, famous variable).

[*This List is continued on the next page.*

6. *Auriga*, the *Charioteer* (*a*, *Capella*)
7. *Ursa Major*, the *Greater Bear* (*a*, *β*, the *Pointers*).
8. *Canes Venatici*, the *Hunting Dogs* (*a*, *Cor Caroli*).
9. *Coma Berenices*, *Queen Berenice's Hair*.
10. *Bootes*, the *Herdsman* (*a*, *Arcturus*).
11. *Corona Borealis*, the *Northern Crown*.
12. *Serpens*, the *Serpent*.
13. *Hercules*, the *Kneeler*.
14. *Lyra*, the *Lyre* (*a*, *Vega*).
15. *Cygnus*, the *Swan* (*a*, *Arided*; *β*, *Albires*).
16. *Pegasus*, the *Winged Horse*.
17. *Andromeda*, the *Chained Lady*.
18. *Triangula*, the *Triangles*.
19. *Aries*, the *Ram*.
20. *Taurus*, the *Bull* (*a*, *Aldeboran*; *η*, *Alcyone*, chief *Pleiad*).
21. *Gemini*, the *Twins* (*a*, *Castor*; *β*, *Pollux*).
22. *Cancer*, the *Crab* (the cluster is the *Beehive*).
23. *Leo*, the *Lion* (*a*, *Regulus*).
24. *Virgo*, the *Virgin* (*a*, *Spica*).
25. *Libra*, the *Scales*.
26. *Ophiuchus*, the *Serpent Holder*.
27. *Aquila*, the *Eagle* (*a*, *Altair*).
28. *Delphinus*, the *Dolphin*.
29. *Aquarius*, the *Water Carrier*.
30. *Pisces*, the *Fishes*.
31. *Cetus*, the *Sea Monster* (*o*, *Mira*, remarkable variable).
32. *Eridanus*, the *River*.
33. *Orion*, the *Giant Hunter* (*a*, *Betelgeux*; *β*, *Rigel*).
34. *Canis Minor*, the *Lesser Dog* (*a*, *Procyon*).
35. *Hydra*, the *Sea Serpent* (*a*, *Alphard*).
36. *Crater*, the *Cup* (*a*, *Alkes*).
37. *Corvus*, the *Crow*.
38. *Scorpio*, the *Scorpion* (*a*, *Antares*).
39. *Sagittarius*, the *Archer*.
40. *Capricornus*, the *Sea Goat*.
41. *Piscis Australis*, the *Southern Fish* (*a*, *Fomalhaut*).
42. *Lepus*, the *Hare*.
43. *Columba*, the *Dove*.
44. *Canis Major*, the *Greater Dog* (*a*, *Sirius*).
45. *Argo*, the *Ship*.

CHAPTERS ON MODERN DOMESTIC ECONOMY.

III.—THE FRAMEWORK OF THE DWELLING-HOUSE (*continued*).

GENERAL PRINCIPLES OF CONSTRUCTION.

IT is now generally understood that the admission of fresh air into buildings and its maintenance therein under suitable conditions of temperature and pressure, is almost, if not quite, as important as the exclusion of damp and the choice of a thoroughly sound foundation and sub-basement.

Pure air consists of about 79 per cent. of oxygen, and 21 per cent. of nitrogen by measure, with 1 part of carbonic-acid gas in every 2,500 parts of the atmosphere. Air of this nature, at a temperature varying from 55° to 65° Fahr., may be considered to be typically perfect for the promotion of health in the average human being. To secure and maintain such an atmosphere in the dwelling-house is a practical impossibility, for reasons which we shall give hereafter; but it must not be imagined that, because of this, an insalubrious state of affairs must inevitably follow. There is a margin, and a very wide margin, within the bounds of which freedom from all evils, arising from impure air, is available.

The process of slow combustion which goes on in the animal body requires the presence of oxygen; and the nitrogen of the air acts as a dilutant. A somewhat similar combustion goes on more rapidly in the employment of fires, gas, and oil flames. The animal body, again, throws off waste products from its other glandular organs, such as the secretion of noxious liquids and gases, which emanate from the skin, tegumentary organs, and mucous membranes.

A qualitative analysis of the products of combustion in an ordinarily-inhabited apartment would show that the air is vitiated with carbonic acid, the vapour of water, waste animal tissues, carbon in the form of smoke and soot, carburetted and sulphuretted hydrogen, and a trace of various salts. To these must be added the indirect accession of germs of putrefaction, and, may be, of disease, together with vapours and gases from vegetable matters and the external atmosphere.

It has been estimated that, on an average, the adult human being inhales from about 15 to 20 cubic feet of air during the course of an hour, and exhales almost an equivalent amount of carbonic acid gas. During that period, also, about 2½ oz. of aqueous vapour, charged with effete matters, are given off from the respiratory passages, other mucous membranes, and the skin. It has also been calculated that a jet of gas, which consumes 5 cubic feet per hour, uses up all the oxygen from 50 cubic feet of air, and produces 5 cubic feet of carbonic acid, 10 cubic feet of aqueous vapour, and an appreciable proportion of carbon particles and carburetted and sulphuretted hydrogen. Yet, nevertheless, the generation of impurities from any given flame is not directly proportional to the size of the flame, for a jet turned on to three-quarters of its full extent will consume almost as much oxygen as one fully turned on; so that it is more advisable to employ a few burners fully turned on, than a larger number partially turned down, in the production of a given degree of illumination.*

From what has been stated, it is evident that the combined influence of natural and artificial combustion tends to render the atmosphere unwholesome, and that it does so from a variety of causes. It has, moreover, been found that the quantity of carbonic acid gas in the atmosphere serves as an index to the suitability of the latter; not so much on account of its direct action as a poison to the respiratory system of animals, as being in constant association with other more powerfully noxious elements. Physiological biologists have shown that the processes of life in both plants and animals are essentially the same. The old notion that plants respire the products of exhalation from animals is not strictly correct. The carbonic acid given off in the process of animal respiration would act as a poison upon that animal if it were re-inhaled; but taken as a food into the alimentary system, it would act beneficially. Now, that is exactly what happens in the vegetable kingdom; the carbonic acid resulting from the expiration of animals, and the decay of dank vegetable and animal matter, is taken up through the stomata of the leaves of plants, which are in reality a part of their assimilative system, and through the metabolism which goes on there, the oxygen is liberated, and the carbon appropriated, in the elaboration of the sap. Thus a balance is secured, and the purity of the general atmosphere remains unimpaired.

Decaying matters are always associated with the fostering of germs, and the elimination of poisonous, foul-smelling gases, the most deleterious of which is sulphuretted hydrogen, easily recognisable by its characteristic odour of putrid eggs. As we have already stated, however, the quantity of carbonic acid in the air may be taken as a reliable indicator of its purity or impurity. Wholesome air ought not to contain more than about ·06 per cent. of carbonic acid; the presence of 1 per cent. is harmful, but when it reaches the proportion of about from 10 to 12 per cent., the air becomes absolutely poisonous.

In virtue of the laws which regulate the diffusion of gases, the carbonic acid and other gases given off as the products of combustion tend to spread themselves throughout the apartment, although, bulk for bulk, the carbon dioxide is one-and-a-half times as heavy as ordinary air. Its distribution is further accelerated on account of its greater temperature, for it usually leaves the body at about 98° Fahr., and the flame of a lamp at a considerably higher temperature, whereby it tends to rise towards the ceiling. The course of circulation is as follows:—On reaching the

* "The Medical Annual." London, 1883-4, p. 119.

ceiling the vitiated air passes horizontally to the walls of the apartment, where, becoming cool, it descends to the lower levels, to be rebreathed and consumed, and to escape partially through the chimney. When the room is overheated, or the outer atmosphere is very much colder than that within, the currents which descend along the walls, especially along window-frames and unsheltered walls, become suddenly reduced in temperature, and in their consequent rapidity of falling become a constant source of draughts.

It is thus easy to understand how it is that unventilated rooms which are more or less constantly occupied tend to promote every form of disease, from a simple headache and a sensitiveness to cold to pulmonary consumption, fever, asphyxia, and death. The introduction of fresh air and the removal of foul air, not only without the production, but with the abolition, of draughts, combined with a due regulation of the temperature of the room, must be regarded as indispensables in the construction of a healthy house. To accomplish these results at a minimum of expense has been the aim of many inventors since "Tobin's Tubes" were brought into use. It may interest our readers to learn that a most efficient instrument has been devised for this purpose at a trifling cost by Mr. J. E. Ellison, of Leeds, the recipient of Silver and Bronze Medals at the recent Health Exhibition. The following is a brief description of his patents.

"Ellison's Patent Conical-Perforated Bricks and Air-Grates" consist of red, white, or salt-glazed bricks of standard dimensions. The thickness of the brick is perforated by a series of conical apertures, terminating by a wide mouth at one, and by a narrow mouth at the opposite, face. When used as inlets for fresh air, the larger opening ought to be placed inside; the incoming current of air is by this means effectually radiated and diffused, so that all draught is avoided. This may be readily demonstrated by blowing a column of air through the conical aperture with a pair of bellows.

Fig. 1 is an explanatory sketch of the "Radiator Ventilator," which has been constructed in such a way as to admit air into any apartment without draught. It is one of the best appliances that has hitherto been brought forward; it not only accomplishes the purposes for which it was specially designed, but is worthy of the highest recommendation, inasmuch as it comes within the reach of all, and can be fixed to any existing dwelling-house. The "Radiator" is composed of a flat disc, bearing divisional planes placed crosswise behind its surface, which, on closing the apparatus, slide into the box, B, Fig. 1, fixed in the wall of the building. By means of its four wedge-shaped compartments, the air which is admitted through the outer grate, A, is dispersed in all directions in the apartment, as shown by the arrows in the figure; and so effectually that no draught is felt. The ventilator should be fixed preferably from 4 ft. to 8 ft. above the floor of the room, and in a position free from obstruction for about a foot on every side; it ought not to be opened more than about 1½ in. If placed behind a hot-water pipe, the incoming air is warmed; the same result may be accomplished by supplying the air to the ventilator through a shaft built in the wall, which can thus admit of being suitably warmed. It thus fulfils all the requirements of a perfect inlet ventilator.

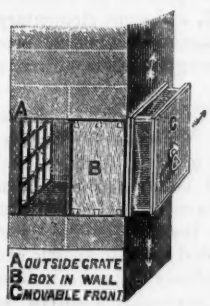


Fig. 1.—Ellison's "Radiator" Ventilator.

Reviews.

THE ANTIQUITY OF MAN.*

By Edward Clodd.

NUMEROUS as have been the discoveries of unground stone tools and weapons, which are characteristic of the Palæolithic Age, in the valleys of the Thames, Lea, and other rivers, there had been until the fall of last year no fragment of man's skeleton found which could be referred to that remote period.

Various satisfactory reasons for this absence of human bones are adduced, among others, the absence of bones of other animals of corresponding size, the liability to decay, or, if not burned, to being devoured by the hyænas which then abounded. But none the less was some evidence desired which might enable us to know what were the physical features of these chippers of flint.

When, therefore, in the judgment of such an expert in palæontology as Sir Richard Owen, the remains of a veritable man of the Ancient Stone Age have been unearthed, the interest of the volume before us, describing and illustrating the subject, is manifest. It would seem that in the course of some excavations at the East and West India Dockworks, at Tilbury, in October, 1883, portions of a human skeleton were found at thirty-four feet below the surface in a bed of sand, and although these were more or less detached and, in the case of the pelvis, smashed by the navvy's pick and scattered by the shoveller, enough was recovered by the care of Mr. Donald Baynes, the company's engineer, for transmission to Sir Richard Owen. He identifies them as having belonged to a male, the jawbone indicating, by the loss of masticating teeth, that he had reached, what was probably then exceptional, old age. In a technical description, which thinly veils its humour, Sir Richard says: "The smooth, unbroken surface of the molar tract tells plainly that the aged palæolithic individual went on labouring for his subsistence long after the loss of his grinders, and putting such few teeth as remained to their utmost powers of trituration."

With his heavy polished flint weapons he had slain the mammoth or captured it in a pitfall. In the days of his youth, "iron-jointed, supple-sinew'd," he had chased the deer, the bison, and other wild beasts that roamed through the thickets then covering the site above which Westminster Abbey and the Tower of London stand. During the short and special seasons of the variable climate of that epoch his dainties would be the crab-apple, the sloe, the hips and haws; while for winter store hazel-nuts, beech-nuts, and acorns would be gathered. But as eye grew dim and natural force abated, "the preparation for swallowing raw and hard fruit polished off the crowns of the few remaining teeth of the ancient, probably primitive, dweller of the Thames valley."

The report which Sir Richard Owen gives concerning the cranial capacity of this specimen is of value, although it affords no clue to connect it with any existing race, such as, according to Professor Boyd Dawkins, we have to connect the cave-men of the Old Stone Age with the Eskimos. In shape, the skull approaches the dolicho-cephalic, or long-headed, and "the contraction and slope of the low and narrow forehead and the prominence of the frontal sinuses are matched by low Australian and Andamanese skulls," whilst the eminences and depressions indicative of cerebral convolutions are few and feebly indicated. As the higher

* "Antiquity of Man, as deduced from the discovery of a Human Skeleton at Tilbury, North Bank of the Thames." By Sir Richard Owen, K.C.B., &c. (London: Van Voorst. 1884.)

the animal, the more complex, more numerous, and irregular are these creases or convolutions, the skull of this palæolithic man is of the character we should have expected. and like indications of brute force are given by the rest of the skeleton in the contrast of strong muscular characters with the low cerebral ones.

The bones had derived a dark brown colour from the powdery sand in which they were imbedded. Below this is the gravel known as "ballast," and above it are successive layers of thirty feet in thickness, the time of deposition of which is the measure of the period from the time of Drift-man until now. The present level of the surface of the banks of the Thames is about the same, geologically speaking, as it was when it was forded at Corday-Stakes by the second batch of Roman invaders (52 B.C.), and the different and various soils from surface to sand have been laid down tranquilly in keeping with that uniformity of causation which excludes theories of rapid or violent action. In the stratum just above the sand, fragments of decayed and blackened wood were found, showing the existence of vegetation long ago imbedded in the overlaying mud. Above this, beds of peat, mixed with clayey matter, alternate with layers of mud till we reach the surface clay. Data for reckoning the lapse of time in which years are "as moments in the eternal silence" fail us, and we are, as Sir Richard observes, unable to conceive the difference between the recorded times "since the actual surface was first trod by a Roman soldier, and the unrecorded time since the sandy soil, eight strata and thirty feet lower down, was trod by the man whese osteological characters are given above." It is a question whether the sand is a more recent foundation than the celebrated gravel-beds of the Somme Valley in which M. Boucher de Perthes first discovered unpolished stone implements, and revolutionised all past ideas of man's place in geological time. Be it contemporary or later, the Tilbury skeleton throws no light on the presence of man in tertiary times, whether of *Homo alalus* (dumb-man) in the Miocene age, or of *Homo pithecanthropus* (ape-man) in the Eocene age. It is enough that this skeleton adds confirmation of the already superabundant evidence of the remote antiquity of man in western Europe, and of his primitive condition as one inferior to the lowest savages extant.

SOME BOOKS ON OUR TABLE.

Geology of Weymouth, Portland, and Coast of Dorsetshire. By ROBERT DAMON, F.G.S. (London: Edward Stanford. 1884.)—The tourist or visitor to the Dorsetshire coast can have no better guide to its physical structure, its geological, palæontological, and archæological history, or its existing fauna and flora, than Mr. Damon's excellent work, the new and enlarged edition of which lies before us. It is fully illustrated by maps, plans, and capital drawings of the most common and characteristic fossils, and contains an amount of detail on all the subjects treated of which may fairly entitle it to be ranked as exhaustive. The student who will spend a fortnight exploring the coast between Swanage and Bridport with Mr. Damon's book in his hand, will acquire a more intimate knowledge of geological phenomena, and realise in an infinitely more impressive way the strange history of past life upon our globe, than he can by any possibility ever do by six months of mere "grind" at the whole of the South Kensington cram-books put together. We cordially recommend it.

The Saxon Invasion, and its Influence on our Character as a Race. By J. FOSTER PALMER, L.R.C.P., &c. Transactions of the Royal Historical Society. (London. 1884.)—All Englishmen who are curious to know something of the rock whence they were hewn, and the hole of the pit whence they were digged, will find a mass of curious and interesting information in Mr. Palmer's pamphlet. He regards Vortigern, Arthur, Hengist, and Horsa, &c., as really historical personages, and not as the mere myths it is now fashionable to consider them.

London Water Supply. By Colonel Sir FRANCIS BOLTON, C.E. (William Clowes & Son. 1884.)—This is the third volume on the subject of the London Water Supply which has reached us for review since the opening of the Health Exhibition, and it is the most exhaustive of them all. As a manual at once for the consumer and for the waterworks shareholder, it leaves nothing to be desired; in fact, it may be regarded as a kind of encyclopædia of the subject. The physicist, the mechanic, the statistician, and the lawyer, as well as the householder may each find matter of interest within the covers of Colonel Bolton's portly volume. We fail to see how it can be sold without a serious loss at the almost nominal sum charged for it.

The Spitalfields Genius; the Story of Wm. Allen, F.R.S. Re-told by J. FAYLE, B.A. (London: Hodder & Stoughton. 1884.)—In a proem and seven effective chapters, Mr. Fayle tells the interesting story of the life of the Quaker chemist of Plough-court, Lombard-street, who, born in Spitalfields in 1770, subsequently became famous as one of the most popular lecturers on chemistry of his time, and whose philanthropy was as extensive as his scientific knowledge. How a business man in a dingy City court became the friend and associate of men of the highest social rank and of world-wide eminence, may be learned from the volume before us, in which there is scarcely a dull or dry page to be found. We will not spoil the reader's pleasure by any attempted *précis* of its contents, but refer him to the work itself.

The First Principles of Natural Philosophy. By W. T. LYNN, B.A., F.R.A.S. Second edition. (London: J. Van Voorst, 1884.) As an introduction to physics for use in schools, or for the self-taught student, Mr. Lynn's excellent little book appears to be particularly well adapted. In simple and intelligible language, illustrated, wherever necessary, by diagrams, our author expounds the fundamental principles of Statics, Dynamics, Hydrostatics and Hydrodynamics, Pneumatics, and Optics: treating of the nature of Light and Sound in a concluding chapter. The only mathematical knowledge presupposed on the part of the reader is that of the first six books of Euclid, and some elementary algebra. Should Mr. Lynn ever expand this work, some reference to the conservation of energy might well find a place in its pages.

Reasons for Dissenting from the Philosophy of M. Comte. By HERBERT SPENCER. (London. Williams & Norgate. 1884.)—That Comte was one of the greatest thinkers that this century has produced, it would be idle to deny. His followers, however, are but indifferently contented with this admission, and virtually claim that all exponents of modern scientific thought are indebted to their apostle and prophet for inspiration. Among others who have been accused of borrowing from the "Philosophie Positive" of the famous Frenchman is our own great English philosopher, Herbert Spencer, an accusation which he sets himself to rebut in the pamphlet before us. By the simple method of placing quotations from Comte's writings and from his own in parallel columns, Mr. Spencer shows triumphantly that so far from deriving his inspiration from Comte, he differs from him, *toto cœlo*, on the most vital points. Every one interested in the controversy should read his tract.

Miscellanea.

A Gigantic Oil Well.—On Saturday, October 11, the Christie Brothers' drilling well at Phillips City, Butler Co., Pa., struck the oil-bearing sand and began to flow at a tremendous rate, gushing forth the crude petroleum at the rate of 5,000 barrels per day, and the well will go down in history as being one of the largest wells ever struck in the oil region. The well is still producing at the rate of 180 barrels per hour. This well of Christie Brothers is only 365 feet from the famous Phillips well, which was struck August 30, and is yet producing 2,200 barrels per day. These great wells have paralysed the oil trade, and the oil market has sagged from 75 cents to 62 cents per barrel.

International Exhibition at the Alexandra Palace.—An International Exhibition is to be held at the Alexandra Palace next year, commencing about March 31, and remaining open for six months. Ten per cent. of the gross receipts from admission money is to be set apart for distribution among the principal London hospitals. For this purpose a committee has been appointed as follows:—Chairman, Colonel Sir Herbert Sandford; vice-chairman, Admiral Sir Edward Inglefield; General Sir Michael Kennedy, Sir Henry Pitman, Sir Andrew Clark, Mr. F. D. Dixon-Hartland, and Dr. George Johnson. The exhibition, like those at South Kensington, will not rely simply upon the attractiveness of the exhibits, but will include amusements of a varied nature. The building and grounds are to be brilliantly illuminated by the electric light. Machinery is to be largely represented. A small charge is to be made for space. Mr. E. Ray, 21, Queen Victoria-street, is the secretary.

At a meeting of the Anthropological Institute, Nov. 11, Professor Flower, F.R.S., President, in the chair, Mr. Francis Galton described the object, method, and appliances of the late Anthropometric Laboratory at the International Health Exhibition. He stated that 9,344 persons passed through the Laboratory, each of them being measured in seventeen distinct particulars for the sum of 3d., in a compartment only 6 ft. wide and 36 ft. long. The popularity of the Laboratory was so great that its door was besieged by far more applicants than could be admitted, and many persons made repeated attempts and waited long for their turn, but at last gave up their attempts as hopeless. So many applications have been made abroad and at home for duplicates of the instrumental outfit that it was advisable that any suggested improvements in them should be considered before they became established in use. The present paper was to invite discussion.

Petrified Wood.—The petrified wood which is so abundant in the United States territories of Arizona, Wyoming, and Rocky Mountain regions is rapidly becoming utilised by the practical Americans. In San Francisco there is now a factory for cutting and polishing these petrifactions into mantelpieces, tiles, tablets, and other architectural parts for which marble or slate is commonly used. Petrified wood is said to be susceptible of a finer polish than marble, or even onyx, the latter of which it is driving from the market. The raw material employed comes mostly from the forests of petrified wood along the line of the Atlantic and Pacific Railway. Several other companies have also been formed to obtain concessions of different portions of these forests. Geologists will regret the destruction of such interesting primeval remains, and some steps ought to be taken to preserve certain tracts in their original state.—*Engineering.*

Mr. T. Mellard Reade, C.E., who has devoted much attention to chemical denudation of the earth's surface, in his presidential address to the Liverpool Geological Society this session, dealt with "The Denudation of the Two Americas." He showed that 150,000,000 tons of matter in solution are annually poured into the Gulf of Mexico by the river Mississippi; this, it was estimated, would reduce the time for the denudation of 1 ft. of land over the whole basin—which time has hitherto been calculated solely from the matter in suspension—from 1 ft. in 6,000 years to 1 ft. in 4,500 years. Similar calculations were applied to the La Plata, the Amazons, and the St. Lawrence, Mr. Reade arriving at the result that an average of 100 tons per square mile per annum are removed from the whole American continent. This agrees with results he previously arrived at for Europe, from which it was inferred that the whole of the land draining into the Atlantic Ocean from America, Africa, Europe, and Asia contributes matter in solution, which, if reduced to rock at two tons to the cubic yard, would equal one cubic mile every six years. [In connection with this, the attention of our readers is drawn to an article on "River Action on Land," Knowledge Vol V., p. 270, in which such statistics are shown to be unreliable.—Ed.]

"Let Knowledge grow from more to more."—Alfred Tennyson.

Only a small proportion of Letters received can possibly be inserted. Correspondents must not be offended, therefore, should their letters not appear.

All Editorial communications should be addressed to the Editor of Knowledge; *all Business communications to the* Publishers, *at the Office, 74, Great Queen-street, W.C.* If this is not attended to delays arise for which the Editor is not responsible.

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SOME OF YOUR CORRESPONDENTS.

[1511]—It appears to me that if Mr. Fowler's facts are correct, his explanation of the "talisman" is a sufficient one. The question is not, "What connection is there between the figures and the powers attributed to them?" but "What connection did the Egyptians or Asiatics, or any one else, suppose them to have?" And it is quite conceivable that superstitious people would see "magic" in the fact that the same total could be obtained in several ways. Why they saw it was probably because they knew no better.

Mr. Mathias will find his "problem" abundantly answered in letter 1501. If he will take the trouble to put four such squares together in the form of a square (or arrange the numbers four times over on a chess-board), he may obtain 34 in a sufficient number of ways to satisfy him. Any consecutive four numbers in a straight line, whether horizontal, perpendicular, or diagonal, will cast to 34; and so will any square of four numbers, or the four corner numbers in squares of 9, 16, 36, 49, or 64 numbers. And there is a perfectly mechanical process by which he may produce from this "magic square" a very large number of others having precisely the same properties.

But, sir, would it not be well to stamp out the "magic square" epidemic before it sets in badly. Some time ago we had a severe attack of it, which was only cured by a rigid refusal to publish any more squares. You stand a good chance of being deluged with them for the next few weeks.

"W. S. B." tries to galvanise the long-defunct "Fifteen puzzle" into life. "O! W. S. B.," don't you know your question (in which, by the bye, I suppose 13, 14, 15 is wrongly printed for 13, 15, 14) has been asked and answered a thousand times? If *all* questions were answered as often, the world itself would not contain the replies to correspondents that would be written. You want to know how to get the numbers consecutive. There is one most simple and effectual way. Carefully remove "15" from the box and place it after "14." Should you not be satisfied with this method, invert the "6" and the "9" and work the puzzle over again; you will find it will come right.

If this will not suit you either, it will be time your friends should look carefully after you, for your case will soon be hopeless. W.

[I entirely agree with "W." that we have had more than enough of the "Magic Square" and the Fifteen game. Any future contributions, be they letters or queries, on either of these subjects, must be "declined, with thanks."—Ed.]

FOREGLOW.

[1512]—There was a very fine foreglow here (Maidstone) on Nov. 7, almost equal in brilliancy, if not in duration, to any seen by me last winter. For some time the sky next the horizon was of a deep orange colour. At 6.30 this band of orange became almost white, whilst above this was the splendid crimson glow, almost an equal-sided triangle in shape, the apex reaching half way to the zenith. At 6.45 it quickly disappeared, there being no colouration after that time. The rest of the sky was deep blue, absolutely no clouds being visible on the eastern half. About 7.10 the sun rose, but there was no red colouration.

It seems to me that these glows differ in two respects from a usual dawn: that they occur and *disappear* some considerable time

before the sun rises; and that the crimson tint is often apparently *upon the ground of the sky itself*, and not upon clouds, as in an ordinary sunrise. OPIFER.

Nov. 10, 1884.

[It is, of course, *the* characteristic of these fore- and after-glows that they appear long before the ordinary dawn and after sunset: showing evidently that the light must be reflected from *something* at a very great altitude in our atmosphere. The interesting and important question is: What is that something? The cause, whatever it is, has been in operation for at least a year and ten months. There seems to have been a splendid foreglow visible in Paris during the early morning of Nov. 10.—ED.]

THE WEATHER OF 1665 AND OF 1884.

[1513]—Have any of your readers noticed the similarity between the weather of the present year and that described to have prevailed during the great plague in London? We are told that the summer was unusually hot and fine, and the account of the afterglow and the crimson glories of the sky would exactly describe what we have seen during the last twelve months. We have had no plague, but there have been the outbreaks of cholera in Egypt, France, and Italy. Can this have been only a coincidence? On the other hand, the winter before the plague was very severe, and the atmosphere appears to have been more dry and stagnant than it has been this year. K.

A SPLENDID GROUP OF SUN-SPOTS.

[1514]—As we have had of late much to interest us in the activity displayed on the sun's disc—rather against "official" orders—I enclose the drawings of a splendid group that I have done in the interval of three rotations, which is interesting from the fine forms it takes from the straight to the undulating, then to the more detached, still showing a relative affinity.

Aug. 23, 2.30 p.m.

Sept. 13, 3 p.m.

Oct. 5, 10 a.m. (Definition splendid).

Oct. 29, 9 a.m. (Screen definition not good; air unsteady).

Change in a Group of Sun-spots, in the interval of three Rotations. Drawn at the Screen. Power 120, Wray, 3½ in.

GEO. L. BROWN.

LETTERS RECEIVED AND SHORT ANSWERS.

DR. GROTH. You invited my candid opinion on your theories, and I gave it. Now you modestly ask me to insert five sheets (!) of your reasons for adhering to your own notions. I cannot possibly afford the space. There is a growing evil to which a peremptory stop must be put. It is this: that every one whose literary work or pseudo-scientific guesses are unfavourably commented upon here seems to have the idea that he is entitled to occupy columns of KNOWLEDGE in reiterating his ideas. A little more of this, and no paradoxical or quasi-paradoxical work will ever be noticed again, and the authors of such must seek some other form of advertisement.—Some CORRESPONDENT of artistic proclivities sends a picture of "R. A. P." coming condignly to grief in—or out of—a flying-machine. By way of emphasis, the head of the said R. A. P. is coloured green as he moves horizontally, and blue as he is ascending. Like Peter, the policeman, in the "Bab Ballads," the limner "was a merry, genial wag, who loved a mad conceit."—METEOR. Scott's "Meteorology" in the "International Scientific Series" is excellent. So is Buchan's "Handy-book," for practical information. I do not fancy that readers, as a rule, seem to care much for meteorology. The Weather Maps published in our earlier volumes apparently excited but little interest. The solar prominences are uprushes of glowing gas, chiefly hydrogen. See "The Sun," published by Messrs. Longmans & Co.—J. FERGUSON. The "Comozants," or "St. Elmo's Fire" of sailors, is simply a

form of the so-called "brush discharge" of the ordinary electrical machine. It is common enough at the mast-heads and yard-arms of ships during thunderstorms.—An Anonymous Correspondent sends me (in connection with Mr. Tindall's letter, 1500) a cutting from "Industry" for May 13, 1880, describing an eye-photometer, the invention of Mr. William Ackroyd, dependent on the sudden shortening of the rays from an artificial star, as the source of light to be measured is approached.—Walter G. Woolcombe. Once more, Mr. Proctor has ceased to lecture for good and all, and cannot relax this rule for *anybody*. Besides, he is not in England.—Anonymous. Thanks for correction *re* p. 382. It is noted elsewhere.—E. A. Tindall. Will test the apparatus when it reaches me.—Thos. Allsop. The semi-diameter of the earth's penumbra = the parallax of the moon + the parallax of the Sun + the Sun's semi-diameter, *i.e.* (*vide* p. 383), 59′ 17·1″ + 8·9″ + 16′ 2·4″ or 1° 15′ 28·4″, add $\frac{1}{60}$th (say 1′ 15·5″) to this and we have 1° 16′ 43·9″. Now, in our figure, the radius of the earth's shadow = 44′ 7″ is 1·1 inch. Then we say 44′ 7″ : 1° 16′ 43·9″ :: 1·1 inch : what we shall find to be 1·9 inch; so that we have only to open our compasses to a width of 1·9 inch, and, putting one leg on C in the figure, describe a circle round it. This will represent the penumbra, the times of contact with which we shall obtain from inspection by the aid of our hour-line, LN.—Hugh Clements. No more room to spare for details of your "Weather Cycle."—Hallyards. Nothing akin to M. Flammarion's observation has been made anywhere else. He can *not* mean the penumbra ordinarily so called (see reply above) as it would be ridiculous to speak of that as "égale à la 35ᵉ. partie de l'ombre de la terre." How, though, he separated his penumbra from the real one does not occur to me. Liais's observations of twilight in Rio gave a height of about 200 miles as that of the atmosphere, so Flammarion does not seem much out with his 224 miles, however he arrived at it.—A. H. "The Herring and Sea Temperature" much too long for extract. —G. D. Evans. The only "Almanac Lessons" which have, so far, appear, will be found on pp. 23 and 206 of our fifth volume.—Musafir sends a curious story of his own seeming recognition of a group of deserted buildings and enclosures upon which he came, for the first time in his life, during a walking tour in the Eastern Alps. He heads his communication, "Coincidences," but his experience would rather seem cognate with many of those related in connection with the discussion over Our Two Brains.—Old Moon spins an amusing yarn about being knocked up by one of the crew of a schooner which he commanded, while lying in Loch Inver to see "two stars" which had fallen down and pitched on the "cross-trees, one on each side!" the said stars being a couple of "Comozants" (*vide* reply to J. Ferguson above).—Chas. Rice tells, at considerable length, how his drowned brother was resuscitated by a man who inflated the boy's lungs with his own brandy-laden breath. Many have been recovered in similar cases by artificial respiration. The brandy had nothing whatever to do with it.—H. S. S. I, like you, seem to remember a connected essay by Darwin on the mental development of an infant; but I forget where it appeared. Try back volumes of *Nature*. He quotes observations on an infant of his own, though, on pp. 151 to 153 of his "Expression of the Emotions," &c.—Chas. Few. W. H. France. It is wholly needless for you, and other correspondents, to continue to write that the figure in letter 1490, p. 372, is a magic square. That is evident on inspection. What a "Lover of Things Occult" wished to know—as I understood—was the connection between the figures he gave and the supernal powers attributed to them, and this nobody but Mr. Mathias has attempted to touch.—Anonymous. The headless chicken of your paragraph is obviously a "Great gooseberry," from some American paper.—W. R. P. You must use your own discretion. The fact of such a form of expression appearing "in print" proves but little, indeed. What is to hinder a swimming-master or a conjurer from dubbing himself "professor"; the proprietor of a middle-class day-school, held in one room, from calling it a "college"; or a man from advertising a common needle as "a sewing-machine"?—J. Jones. See Glazebrook's "Physical Optics," published in Longmans' "Text-books of Science."—One Who Wants to Learn. "Whitaker's Almanack" is the best and most trustworthy after the "Nautical," but, of course, it does not contain the mass of information which the latter does. Yes; a 2½-inch telescope with a power of 180 ought to divide ε^1 Lyræ, and even theoretically ε^2.—M. Weldon. The conductor of this journal has nothing to add to his quoted expression of opinion. See paragraph (in capital letters) with which the heading to the Correspondence Column concludes.—W. Young. Received. Regret my inability to attend your conference.—Persifal M. Yearsley. Is the story in any way authenticated? or is it merely a magazine novelette?—John E. Chaster. The Editor of this Journal does not buy back numbers with the advertisement sheets missing! You must advertise them if you want to get rid of them. Were any articles required on the subject you mention, they would, of course, be committed to Mr. Slingo.—William Reid. Returned with thanks.—J. T. E. Thanks; but the method you illustrate is "as old as the hills." Certainly, I was familiar with it when I was fifteen. The figure *looks* more simple, but, if you try for yourself, you will find that the necessary calculations are certainly longer and more complicated.—J. Duncan. I cannot engrave a figure here, but see Loomis's "Treatise on Astronomy" (not his "Practical Astronomy"), pp. 154 and 158; or Brinkley's "Astronomy" (by Stubbs & Brünnow), pp. 132 and 133, though into the latter demonstration rudimentary trigonometry enters.—C. Roscoe's "Elementary Chemistry," published by Macmillan, and Ganot's "Physics," Longmans & Co.—W. Wrong. I really cannot afford the space merely to give the English names of the letters of the Greek alphabet. See Cassell's "Elementary Lessons in Greek."—Sharp & Co. Delayed through being addressed to the Editor, instead of to the Publishers.—A Casual Reader. See answer to—well, to every initial in the alphabet—*re* letter 1490.—J. A. M. See Darwin on sexual selection in his "Descent of Man."—Nigel Doble. Put your eye-pieces 10 inches behind the object glasses. There are two sorts of black colouring used in optical instruments; the dead-black in the inside of eye-pieces, tubes, and the like is made of lamp-black, mixed as thick as putty with gold-size, then diluted with turpentine, and painted on with a camel's-hair brush. Stages and outside brass-work are generally blackened with chloride of platinum, brushed on while they are hot.—Starch. The formation and evaporation of clouds is far from being an uncommon phenomenon in daylight. It was seeing them black upon the night sky which must have attracted your attention. As to their shape, &c., see Vol. II. of Knowledge pp. 278 and 326. —W. G. World. No; the focus of the object-glass falls between the lenses of a Huyghenian eye-piece. A 6-inch objective should carry powers from 20 (for comets and nebulæ) to 600 (for very close double stars only). I cannot recommend tradesmen. Read the advertisement columns.—E. P. L. and X. Y. Z. both complain that Mr. Clodd's papers trench, indefensibly, on purely theological grounds. The difficulty of discussing the origin of primitive beliefs —in fact, the origin of man himself—without offending theological prejudices is doubtless very great.—A. Pearson. Thomé's "Structural and Physiological Botany" in Longmans' "Text-books of Science," is excellent. I know nothing of what is demanded of the advanced student in the wretched cram system at Brompton. Anonymous (Ipswich).—Why do you not address the Chess Editor?

A smart trick has, says the *Athenæum*, been played Mr. Max O'Rell by a Yankee firm. Before the sheets of "John Bull's Womankind," sent in advance of publication to America, could be got into type, the work had been translated from an early copy of the French original, and issued by a New York publisher. The author's chance of any profit from the American sale of his book is, therefore, destroyed.

Christmas Presents.—Doubtless for some very good reason, Christmas-tide, now so rapidly approaching, has ever been associated with the giving and receiving of presents. We do not propose, however, to write a homily either in support of or against the custom, though possibly a few adequate reasons from the latter point of view would find favour in the eyes of Paterfamilias. Knowing, however, how much thought is often wasted in selecting suitable presents, frequently with unsatisfactory results, we venture to offer to our readers a suggestion in this direction by again calling attention to the unrivalled claims of photography as an attractive and enduring amusement, not only for young folks, but, we make bold to say, for all who may put it to the test. A day or so back we had an opportunity of inspecting some of the newest sets of portable photographic apparatus offered to the public by the London Stereoscopic Company, of 110, Regent-street, and we were struck by their extreme suitability as presents. Sets completely fitted with all the latest improvements devised for rendering photography a pleasure, can be procured at prices to suit all pockets; the purchase of the most expensive qualities, however, does not involve unreasonable outlay. We may remind our readers, too, that buyers of the better descriptions of apparatus are entitled to avail themselves of a course of free lessons in photography, given by competent instructors on the Company's premises in Regent-street. We saw many desirable sets of apparatus during our visit to the studio, but we can specially recommend to intending purchasers those known as the "Cyclists' ¼-plate," the "Company's ½-plate," and the "Company's whole-plate." These three sets are of different prices, and manifestly of varying sizes; but each is a thoroughly reliable and complete apparatus which cannot fail to please.

XUM

Our Inventors' Column.

So great is the number of inventions now patented that many good things are comparatively lost in the crowd. A succinct account, therefore, by an Expert, of all inventions of really popular interest and utility must be advantageous both to the public and the Inventor, enabling persons to hear of inventions already desiderated by them, and thus acting reciprocally as a stimulant on supply and demand.

AN IMPROVED PAINT-POT.

Paint-pots do not concern everybody, but the number of amateur painters constantly increases, especially, as the "British workman" grows more and more impracticable and independent. Those who do use paint-pots at home should have them as perfect as possible, and such may be interested to know that Messrs. Charles Winn & Co., of Birmingham, and 41, Holborn-viaduct, E.C., are now making an improved paint-pot, in which the improvement consists of a corrugated ring just below the edge of the pot, which gives the necessary strength without having to stiffen the vessel with a wire round the rim. In the new pot the rim is continued after the corrugation for a little distance, and then turned over flat, so as to leave a sharp edge against which the brush can be scraped dry. The old plan of the rounded wire did not wipe it dry, and tended also to allow the paint to run down the outside. This pot is made without solder, so that the old paint can be burnt out without spoiling the joints.

A SAFETY CAP FOR DRAUGHTSMEN'S INK-BOTTLES.

Technical education alone is adding enormously to the number of our draughtsmen of all kinds, and for such habitually using Indian ink or different washes of water-colour in bottles there is constant annoyance occasioned by the accidentally upsetting of these bottles while the cork is out, frequently spoiling their drawings and also losing the ink or wash. It is difficult, too, to use up such inks or washes when they get low in the bottle. If the bottle is at all narrow, when tipping it and inserting the brush or pen to get at the fluid, the brush gets stained higher up than necessary, and marks the fingers, so that it is difficult to keep a drawing clean and neat. In view of this, Mr. F. Fson Almquist, of 100, Finborough-road, South Kensington, has invented a contrivance, consisting of a small cap of indiarubber, to do away with all this trouble. The bigger end of the cap fits over the neck of the bottle. The cork should first be bored with a small hole in the centre, enough to take a glass tube, which is placed through the cork well down into the bottle, leaving above a sort of cup or receiver, to which the smaller end of the indiarubber cap is fitted. The cork should have a small slot previously cut in the side, so that when in the bottle it forms a small air tube. In one side of the indiarubber cap, is a small hole to allow egress to the air. When fitted upon the bottle, it is only necessary to press the cap with the thumb so as to cover the air-hole, and the finger on the other side with a pinching action, so as to compress the air inside the bottle. This drives the fluid up the little glass tube into the receiver at the top, from which a supply is easily taken by brush or pen. The moment the pressure upon the cap is released the air escapes, and the fluid retires from the tube. As long as the cap remains on, the bottle may be thrown about or knocked down with impunity.

A PATENT MARMALADE MACHINE.

Although preserving is mainly a factory business, there are still many persons who prefer to make their own preserves, and especially their own marmalade; and in view of this contingency, Messrs. Follows & Bate (Limited), of Manchester, have invented an orange-cutter designed to prepare oranges for marmalade. The fruit is placed in the hopper at the back of the machine, and by simply working a handle backward and forward the oranges are neatly sliced. This appliance is specifically for kitchen use, since in factories pulping-machines and peel-cutters are required on a large scale. The machine in question is strong and very simple, and its cost is, we believe, exceedingly moderate.

THE PATENT SMOKE-PREVENTOR.

Few domestic nuisances are worse than smoky chimneys, and yet how various are the so-called specific cures for this often intolerable evil. At the recent International Health Exhibition there were many examples of inventions designed to prevent chimneys from smoking, and most decidedly among these was an ingenious contrivance for entirely preventing smoke, and enabling coke, bituminous coal, and even anthracite to be burned. This contrivance s known as the "Patent Smoke-Preventor," and is applicable to any existing grate. It is the property of the "Patent Smoke-Preventor" Association, having offices at 16, Duke-street, Grosvenor-street, W. The invention consists first of an inner and loose fire-basket, a hood reaching entirely to the top of the fire and excluding all cold air from the chimney, and a swinging diaphragm within the hood. Now, the construction is such that the loose fire-basket allows a channel for the passage of air under and at the back of the fire, and it thus becomes highly heated and creates a strong draught. The hot air and the increased draught ensures nearly perfect combustion of the fuel, and very little smoke is formed. The smoke and products of combustion from the fire pass through and over the back of the loose fire-basket and within the hood, and, mixing with the hot air whilst at a high temperature, are effectually oxidised. When the diaphragm is pressed forward—as regulated by the top nob of the hood—the draught is increased, and the whole of the smoke and products of combustion are drawn directly into the current of hot air, and the diaphragm having gills at the back, these form mixing chambers, and by compression the smoke is more completely destroyed. The door in the hood may be closed and opened, and the rate of combustion is thereby regulated. It is claimed to be a perfect cure for smoky chimneys, and any fuel can be burnt. As there cannot be a down draught from the chimney, neither chimney-pots nor cowls are needed. The main advantages of this invention are cheapness, simplicity, thorough ventilation, a fine blazing fire well forward in the grate, a maximum of heat from a minimum of fuel, and, finally, perfect radiation. Another good point claimed is that, with this arrangement, any kind of rubbish and refuse can be burned without the least unpleasantness.

A NEW OCTAGONAL "SYPHON."

Syphon-bottles for aërated waters are now the order of the day, and are in such increasing demand among all sections of the public that any real improvement therein is of very far-reaching importance. The invention known as the new Octagonal Syphon (Vidie's patent), manufactured by Messrs. James Videl & Son, of the Pantin Glass Works, Paris, is externally like the usual syphon-bottle, but the interior of the glass vase is blown into an octagonal form by a new process. The result is a brilliant and sparkling appearance, while the strength is so increased that these new bottles can bear double the pressure of the ordinary, and are therefore twice as safe. The only agent for the United Kingdom and the colonies is Mr. C. Melin, 37, Crutched Friars, Mark-lane, E.C.

THE BALL FILTER.

Filters are now very properly regarded as indispensable to the proper furnishing and equipment of any well-regulated household, indeed, filters are now found in very modest homes, and, probably in time will be common to all. Meanwhile, to many, the question is chiefly, what filter is best? Well, that is not a question to be answered here; but it will interest many to hear of an ingenious invention, the production of the Revolving Ball Filter Company, of 67, St. James's-street, London, S.W., which is certainly worthy of full consideration. This filter may be briefly described as consisting of a spherical metal case, containing a hollow metal ball, filled with animal charcoal or other filtering medium. through which all water designed to be filtered must pass, such passage being secured by a washer, which forms a tight joint around the ball; all organic or other matter in suspense being arrested and held within the filter. A specialty of the filter is the simple method of cleansing, which is done by reversing the ball within the case without removal from the tap, the first passage of water thereafter cleansing the filter of all impurities. There is also a straight passage for water not requiring filtration. Water, after being compelled under pressure to pass into the filter, is again compelled to spread through the filtering material.

SOMETHING NEW IN PERAMBULATORS.

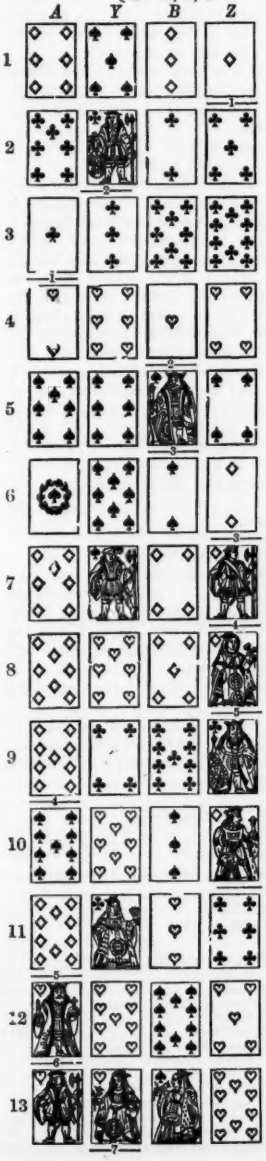
Children are decidedly fortunate in the present age, when so much inventive ingenuity is concentrated on their various needs. Mr. W. H. Dunkley, of Dean-street, Birmingham, has, we believe, for over six years past devoted his thoughts to the improvement of the perambulator, and his latest invention in this line is quaintly known as the "Eclipse" perambucot, the body of which, of papier-mâché, presents an elegant appearance. It is handsomely upholstered, either in silk, satins, velvet, or carriage cloth, and fitted with Dunkley's patent reversible handle. The perambucot has been, we are told, the most successful child's vehicle ever manufactured, Mr. Dunkley having sold 5,000. The bicycle-wheel, with india-rubber tires, is now universally adopted by the manufacturer; this, together with a recently patented spring, being entirely free from vibrations, and also noiseless, is most conducive to the comfort of the child. Mr. Dunkley has just opened showrooms at 76, Houndsditch, London.

Our Whist Column.

["Five of Clubs" has been ill most of the time since his last papers appeared, with malarial fever, and is but now beginning to be himself again. He trusts that weekly or fortnightly games will now appear regularly. They will chiefly be fully annotated games from the *Westminster Papers*. The following is a good game. *Z* was our esteemed correspondent Mr. F. H. Lewis.]

THE HANDS.

B { D. 5, 4, 3. S. K, Q, 10, 3, 2. C. 9, 8, 2. H. A, 3. }
A-B, 4.
B
Tr. D. Kn.
Y
Z
Y-Z, 4.
A leads.
Y { D. None. S. Kn, 8, 6, 5. H. Q, 9, 8, 7, 6. C. Q, Kn, 4, 3. }
A, K, Q, Kn, 2. D. 4. S. 10, 5, 4. H. K, 10, 6, 5. C. } Z
A { D. 10, 9, 8, 7, 6. S. A, 9, 7. C. A, 7. H. K, Kn, 2. }



THE PLAY.

Card underlined wins trick.

1. The score being at "four all," the trump lead from five was not good. Heart Two would have been the correct card. But, *under the circumstances*, Club Ace, followed by the Seven, would not have been bad. A lead from a short suit at such times, especially when weakness is not thereby disclosed too quickly, is sound enough. The hand was played before the days of the penultimate, or Diamond Seven would have been led. *Z* shows his partner his great strength; for it is not to be supposed that *Y* having no trumps, and *B* being presumably very weak, *Z* could not have taken the trick with a smaller card than the Ace.

2. *Z* plays a surer game than *A*.

3. From the fall of *B*'s Eight and *A*'s Seven in trick 2, *Z* knows *Y* must have the four, and therefore (from his lead) another Club. The play of the Ten is no *finesse*, as, if *A* holds the Queen besides the Ace, nothing is lost by letting Queen make. After the Ace has fallen, *Z* knows Queen to be with *Y*.

4. *A* should have led a Spade, as that is most probably his partner's suit.

5 and 6. *A-B* have command of Spades. *Z* is now numerically weaker in trumps than *A*, but he is not sure of this till trick 8. *A* throws Spade Ace, that he may not stop his partner.

7. *Y* discards his useless Spade. Had he originally discarded from his longest suite—the general rule now when the adversaries have led trumps—his Spade Knave would have been guarded, and worth keeping.

8. *B* has no more trumps; for had he held any above the Seven, he would have headed *A*, first round.

9. If *Z* goes on with trumps, *A* will be left with the long trump, will bring in Spades, and *A-B* will make every other trick. *Z* therefore forces *A*. The point is a pretty one, and shows the importance of attention to details. By leading a Heart at trick 2, and afterwards showing that he held Spade Ace, *A* has left it tolerably clear that he holds the King card in Hearts, without which *A-B* would still have lost, even had *Z* gone on with trumps.

10. The trump King can now be safely played, for *A* has no Spades left. Of course it has to be played anyhow at this stage, as *B* would have gone on with his winning Spades.

11, 12, 13. *A* is forced again; the Queen of Clubs being already "placed" with X, and *A* having to lead from his major tenace, *Y* makes the seventh trick and the game.

*** The notes on Whist, by "Five of Clubs," extended and carefully corrected, are now in the press, and will form a small treatise "How to Play Whist." They will be accompanied by forty fully annotated games, from actual play, illustrating all the principal points of Whist strategy; and by Whist gossip, and the rules, etiquette, &c., of the game.

THE VARIETY OF WHIST.

Sir,—There seems room for another word on the old problem of the hands at Whist, first approached in a satisfactory manner by "Cavendish," in the *Field* of June 10, 1865. His investigation is undeniable, as far as it goes; but I think it overlooks one consideration of some importance in determining the true number of essentially different hands, *i.e.*, hands so different as to require different treatment. It will be best, however, for me to give my own solution first, and then to compare it with others.

It is easy to show that the total possible number of different deals, having no regard to dealer or trump-card, is

$$\frac{\lfloor 52}{\lfloor 39 \, \lfloor 13} \times \frac{\lfloor 39}{\lfloor 26 \, \lfloor 13} \times \frac{\lfloor 26}{\lfloor 13 \, \lfloor 13} = \frac{\lfloor 52}{(\lfloor 13)^4}.$$

So far all are agreed. Let us call this quantity N, its numerical value being something over fifty-three thousand quadrillions. The question is, what corrections are to be applied to this in order to obtain the true number required?

(1.) If we take any one of these N arrangements we can make 52 different games by making each card in turn the trump. Hence we must multiply N by 52.

(2.) The number N includes as different games those cases in which the hands are *numerically* identical, but the *suits* are interchanged. But the play is not altered by turning a suit of Clubs into the same suit of Hearts, and the Hearts into Clubs, provided the exchange is similarly performed in each player's hand. We must then divide N by the number of possible permutations of the four suits, *i.e.* by 4 or 24.

(3.) Finally, we must allow for the fact that, supposing the hands in any deal to be passed round the table in order, such rearrangements appear separately in the total N, although the game is not altered thereby, as we have supposed the lead also to move round, to circulate, in fact, thirteen times in each arrangement. Obviously the correction here is made by dividing N by 4.

It follows from these considerations that the real number of essentially different games is represented by

$$\frac{52}{24 \times 4} N,$$

and this, when worked out, gives the number

29,057,566,289,639,762,787,920,280,000.

The result obtained by Cavendish is twenty-four times as great as this, as he omits the second correction given above. It seems, however, quite necessary, the four suits being equivalent, apart from consideration of trumps, which are otherwise allowed for. The agreement otherwise between the two results is satisfactory, as the methods of solution differ in some respect. This is most likely the correction intended by a somewhat obscure passage in the treatise on "Probability" (written, I believe, by the late Sir J. W. Lubbock), in the Library of Useful Knowledge, which is quoted, but apparently misunderstood, by Cavendish. The first and third of our corrections do not seem to be made in the essay on "Probability," which is naturally concerned with the problem rather from the mathematical than from the practical Whist-player's point of view.

It may assist the mind to grasp the result above stated, if we put it in this form:—Taking the population of the world as sixteen hundred millions, let them all—man, woman, and child—start to play Whist, night and day, at the rate of ten deals per hour; they will exhaust the variety of Whist in about one thousand billion years.—I am, &c.,

W. Arnison Slater.

XUM

Our Chess Column.

By Mephisto.

SOLUTION.

Problem No. 135, by J. Berger, p. 394.

	1. B to Kt7	R × P, or (*a*)
	2. Q to Q4 (ch)	K or P × Q
	3. R to QB6 or B4 mates accordingly.	
(*a*)	1.	R to K3, or (*b*)
	2. R to B2	P × R
	3. Q to Q5 mate.	
(*b*)	1.	K to B6
	2. R to QB6	Any
	3. Q to Q4 mate	

The following game, at the odds of a Rook, was played on the 14th inst., in the second round of the Handicap Tournament now progressing at the City C. C. The quality of Black's play will be found above the usual standard of Rook players.

Remove White's Queen's Rook.

King's Gambit Declined.

White Mr. Gunsberg. (Class I.)	Black Mr. Glover. (Class V.)	White. Mr. Gunsberg. (Class I.)	Black. Mr. Glover. (Class V.)
1. P to K4	P to K4	15. Q to Kt3	QKt to B3 (*i*)
2. P to KB4	B to B4	16. P to R3	P to R4
3. Kt to KB3	P to Q3	17. P × Kt	P × P (ch)
4. P to B5 (*a*)	Kt to KB3	18. Kt to R2	Kt × P ! (*j*)
5. Kt to B3	P to B3 (*b*)	19. Q × P	Kt × B
6. P to Q3	B to Kt5	20. R to Q sq.	Kt × P (*k*)
7. B to K2	B × Kt (ch) (*c*)	21. Q × P (*l*)	R to B sq. (*m*)
8. P × B	P to KR3	22. Kt to Kt4 (*n*)	P to Q4 (*o*)
9. Castles	QKt to Q2	23. P × Kt	Q to K2
10. K to R sq.	Q to R4 (*d*)	24. Kt to B6 (ch)	K to Q sq.
11. P to B4 (*e*)	Q × P	25. P × P	Q to B4 (*p*)
12. B to K3	Kt to Kt5 (*f*)	26. P to Q6	R to K sq.
13. B to Q2	Q to R6 (*g*)	27. Kt × R	B to Q2 (*q*)
14. Q to K sq.	P to QR4 (*h*)	28. Q to B8	B × Kt

White mates in two moves.

NOTES.

(*a*) Here is a paradox for Mr. Foster to explain. Why should good work be capable of injuriously affecting its author? Instead of accepting the Gambit with that courage, minus discretion, characteristic of players receiving large odds, Black is actually prepared to beat us with our own analysis, by playing the Gambit Declined, previously analysed in these pages. 4. P to B5 is played with the desire to lead Black off the beaten track, as much depends, in giving the odds of a Rook, to gain an advantage in the opening. Against even play, it is not a good move, as Black can attack the P on K4, and thus break up White's centre, with the probable loss of a Pawn.

(*b*) This move effectually disposes of White's chance to develop his game; he is now compelled to play P to Q3, which blocks in his B. B to B4 would be bad, on account of P to Q4. This shows the weakness of 4. P to B5. Moral—"Never make use of bad means."

(*c*) It is of some advantage to White to have the Black KB off, that commanding diagonal. As a rule, a KB in the opening of a game is more useful than the opponents QKt. Now, P to Q4 was the proper move.

(*d*) White had fondly hoped that, having missed the opening, Black would give him a chance in the middle game, by Castling K's side. Instead of which, Black aims at reducing the game by simple liquidation. To win the RP has its drawbacks, as it mostly puts the Q out of play in the early part of the game, but "a Pawn's a Pawn for all that," especially when it gives Black a powerful passed P.

(*e*) Preferable to P to QR3, as it blocks Black's advance.

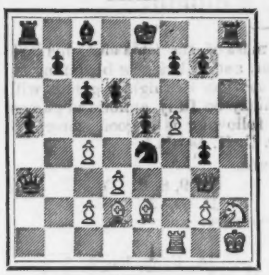
(*f*) With a view to an attack.

(*g*) To reach B4.

(*h*) Necessary, to prevent B to Kt4, but overlooking White's next move.

(*i*) Black had an inconvenient alternative, to submit to Q × KtP, but in playing QKt to B3, Black initiates a remarkable combination to reduce the disadvantage of his position, arising from his loss of time in capturing the QRP, also from his neglect to take advantage of 4. P to B5 by playing P to Q4 at the proper moment.

(*j*) A very good move. Black has opened his R on the White K,



Black.

White.

and now threatens to regain his piece. If Q defends B, then Kt × B, followed by P to Kt6. At this stage White had some misgivings as to the ultimate result of the game.

(*k*) A plausible idea, showing sound judgment. If now P × Kt, as Black expected, then P to KKt3 with a safe game and a winning superiority. If Black had attempted to defend the Kt, then the following might be the result:—Q to Kt5. 21. Q × P, R to B sq. 22. Q to Kt5, Kt to Kt8. 23. Kt to Kt4, R to R sq. (ch). 24. K to Kt sq., Kt to B6. 25. Kt to B6 (ch), K to B sq. Now, we do not see any way for White but to draw by 26. Kt to R7 (ch), R × Kt, and now give perpetual check on Q8 and Kt5. Other ways of playing might lead Black into danger.

(*l*) A desperate move, as Black may reply with R × Kt (ch) and then withdraw the Kt, but, considering that White, if he played P × Kt, would not have had much chance left to win, this was the most likely, though daring, move to play in a game at odds, and, as the result proved, White was right in his choice of evils.

(*m*) Apparently afraid of allowing free play to the Q, but Black could aford to do so without much danger; *i.e.*, R × Kt (ch). 22. K × R, Kt to Kt3. 24. Q to Kt8 (ch), K to Q2. 25. Q × P (ch), K to Q sq. 26. P to B6, P to Q4, with a safe game.

(*n*) "The strategy, the sacrifice, the blow,
Sudden, but strong, that lays the victim low."

More strategy than anything else. Had White now played P × Kt, then B × P would have given Black a good game. The position is now an interesting one; we have spent some time in examining it, the result of our analysis being that, whatever Black did, White would obtain some attack. Of course he might avoid disaster by taking his chance with B to Q2, to which White would have replied with 23. Kt to B6 (ch), K to K2. 24. Q to Kt5, K to Q sq. 25. P × Kt, K to B2. 26. B to Kt4. In this case, unless there is more in the position than we have seen, Black (considering the odds given) might have successfully resisted White's attack.

(*o*) Black played P to Q4 with the intention of bringing his Q into play. Kt to Kt3 would have led to an attack, but not, as Black feared, to the loss of the game; *i.e.*, Kt to Kt3. 23. Kt to B6 (ch), K to K2. 24. Q to Kt5, K to Q sq. (best). 25. Kt to R7 (ch), P to B3. 26. Q to Kt7, R to K sq. 27. Kt × P, B to Q2. 28. B to R5, &c.

(*p*) He had no good move to prevent the threatened advance of the QP.

(*q*) If K × Kt, mate in three follows.

ANSWERS TO CORRESPONDENTS.

*** *Please address Chess Editor.*

E. R. M.—Why, certainly. Every piece on the board must have its use, even if only to prevent a dual, but therein lies the difference between a fine composer and an ordinary one. While the former will execute an idea with but few pieces, the latter will require much more force for the same object.

R. P. H., C. Planck, H. W. Sherrard.—Problems received with thanks.

Tyro.—In Problem 134, if 1. P to Q4 (ch), P × P en passant (that is, as if the P had only played to Q3) and no mate follows.

S. B. C.—If in 135, after 1. B to Kt7, R × P, you play R to B4 (ch), then Kt × R, and there is no mate.

W. Parker.—Solutions incorrect.

Uncle John.—How about 1. R × P? 135 incorrect.

Littlehampton.—In Berger's Problem, if 1. Q to B sq, P Queens.

W. Mathias.—Solution right.

W., H. W. Sherrard, Geo. W. Thompson.—Solutions correct.

J. Allport.—Problem is quite right. Try again.

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